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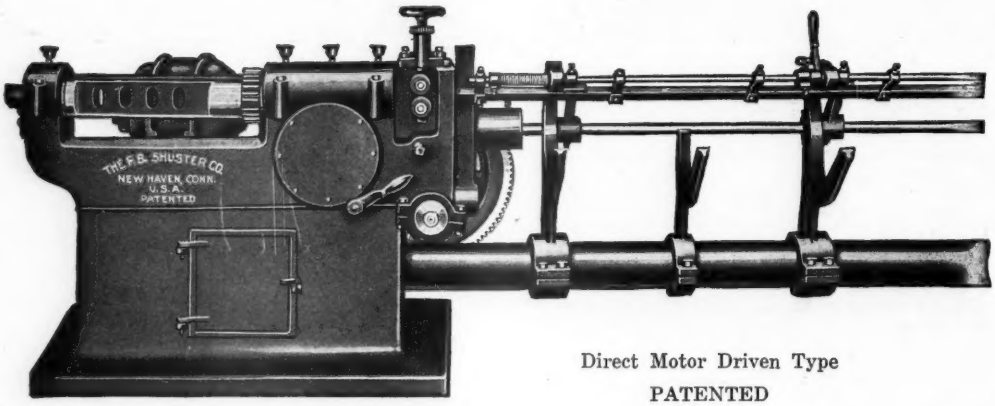

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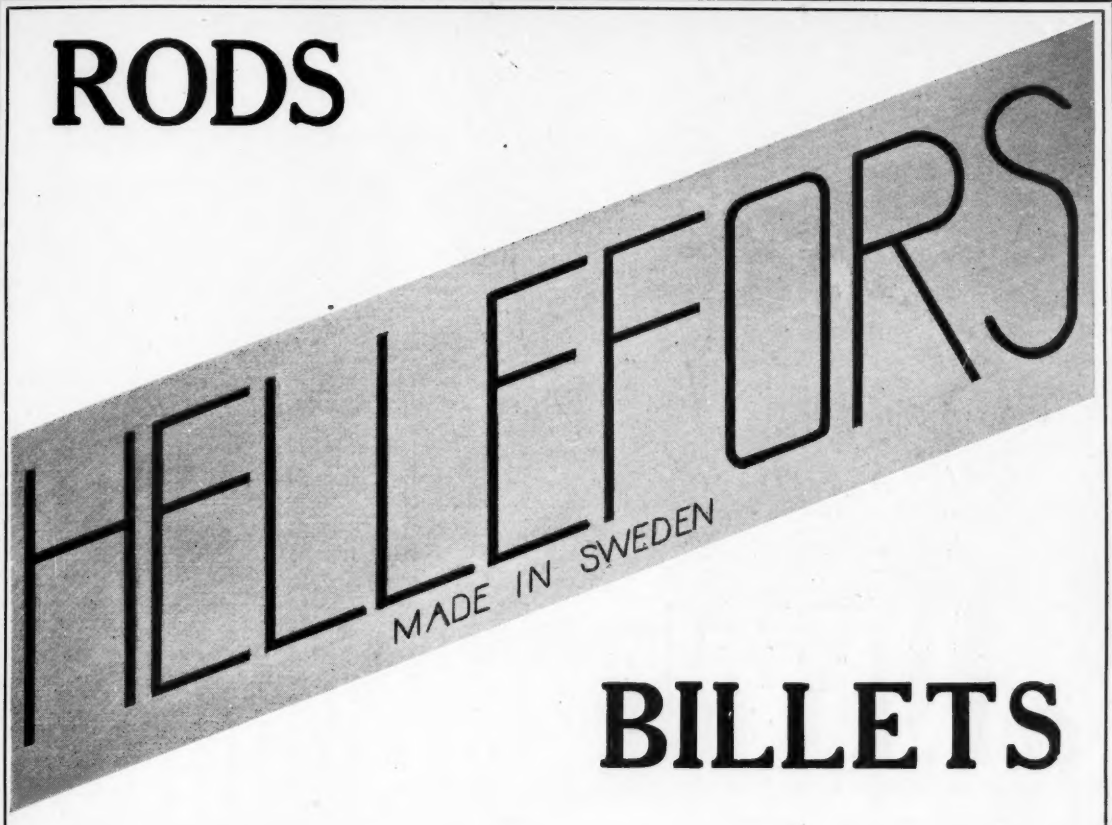

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IN these days when transatlantic airplane hops are becoming almost as commonplace as swimming the English Channel we have the satisfaction of keeping up with the changing fashion. For the monthly hop of Wire & Wire Products to Europe is steadily increasing, and while our reception there is not spectacular we have our measure of welcome.

* * *

American machinery manufacturers will take note that certain German wire mesh producers have recently ordered a considerable number of American made machines. Germany has for a long time supplied her own as well as foreign needs in this line and the news of this purchase should come as a stimulating compliment to the American trade. The machines ordered are for use on hard steel whereas German machines are designed chiefly for soft steel.

* * *

Again England scores a point in our editorial department. This time with an excellent article by a noted authority, Mr. Atkins, whose contribution appears in this issue. The article, which was first read at the recent meeting of the Iron and Steel Institute in London, has provoked important discussion by well known research workers in metallurgy and wire drawing. This discussion will be published in a subsequent issue of Wire & Wire Products.

* * *

By the way, it will interest many of our readers to know that we plan to publish a series of articles on the commercial phases of the wire industry. Books and periodical literature on the manufacturing problems have been scarce enough in the past but on distributions almost nothing has been written. After publication in Wire & Wire Products the articles will be collected and published in book form.

The Publishers.

WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 2 June, 1927 No. 6

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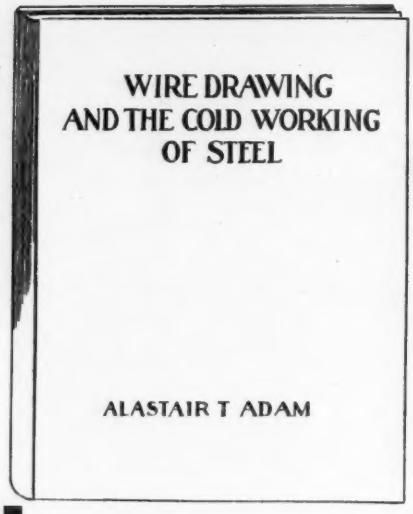

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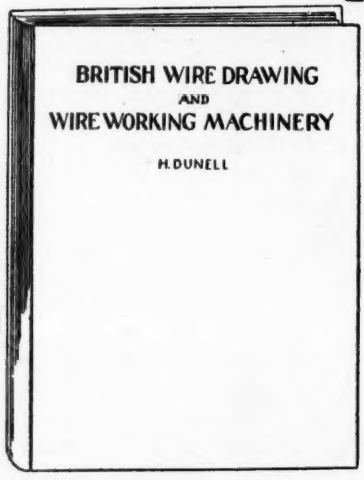

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WIRE
& WIRE PRODUCTS

Vol. 2 JUNE, 1927 No. 6

The Relation of Steel Quality to the Drawing of Steel Wire*

By E. A. Atkins, M. I. Mech. E.
Warrington, England

THE trade of steel wire-making in England, in regard to the weight of material used, is not so important as some of

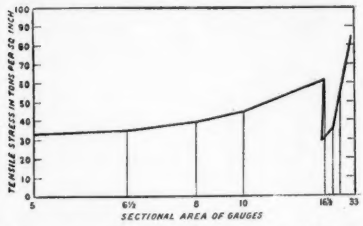


Fig. 2—Tensile strength curve of mild steel wire, drawn from 5 gauge (0.207 in.) unannealed rod to 33 gauge (0.0098 in.) in 20 holes, inter-annealed at 16½ gauge (0.061 in.) Mild steel, chemical analysis: Carbon, 0.140; Silicon, trace; Sulphur, 0.044; Phosphorus, 0.046; Manganese, 0.540%.

the other metal-working industries, but it is extremely important from the point of view of the widespread uses of wire in connection with almost every kind of manufactured article for industrial, commercial, and domestic purposes.

Its importance can perhaps be realised when it is remembered that the actual functioning of a whole complex piece of machinery may depend upon a piece of wire weighing only a fraction of an ounce. Therefore, in consequence of the extended use of wire in constructing the critical parts of machines, the skeletons of buildings, the reinforcing of roads, and the welding together of the parts of articles of all descriptions, it is becoming more and more important that the quality of the steel used should be such that the wire produced from it is exactly suitable to the purpose for which it is intended.

Almost two centuries ago iron wire was drawn from hammered rods, and, in order that a record may be preserved of the type of raw material used, a photograph of short pieces of hammered rod, kindly supplied by Mr. Joseph P. Bedson of Manchester, is herewith reproduced (Fig. 11). It will be observed that the rod is about ¼ in. in width, roughly square in section, and rather lumpy in character. The drawing of such a piece of metal into wire must have been a somewhat formidable operation. Indeed, even at the present time with quite different material and the most up-to-date methods, the drawing of very fine steel wire requires the greatest possible care and consideration. It is conceivable that the lumpy character of the rods which were drawn into wire in days long ago gave rise to the term "ripping mill" or "rumpling mill," as it used to be called, for the first roughing down of rods.

The introduction of Bessemer and open-hearth steel has more or less changed the character of the wire-drawing trade, and instead of the small pieces of wrought iron or steel originally used, pieces of 150 to 300 lb. in weight are commonly produc-

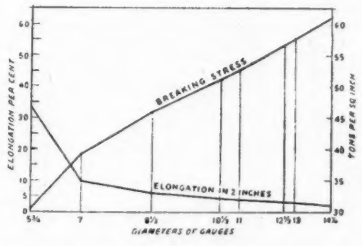


Fig. 3—Tensile strength and elongation curves of steel wire drawn from 5¾ gauge to 14¼ gauge.

Mild steel, chemical analysis: Carbon, 0.10; Silicon, nil; Sulphur, 0.09; Phosphorus, 0.083; Manganese, 0.73%.

*Read at the current meeting of the Iron and Steel Institute.

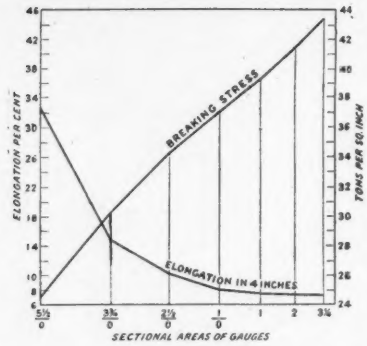


Fig 4—Tensile strength and elongation curves during the reduction of large gauge wire. Mild steel, chemical analysis: Carbon, 0.11; Silicon, 0.053; Sulphur, 0.013; Phosphorus, 0.01; Manganese, 0.38%

ed for the purpose from billets about 2 in. square with rounded edges. These are rolled into rods, the usual size being 5 gauge; heavier sizes are rolled as required.

In spite of all the defects sometimes found in steel and the difficulties encountered in reducing it to fine gauge wire, it must be admitted that the reduction of mild-steel from 5-gauge rolled rod down to 20-gauge wire without inter-annealing is a fairly severe test. This is perhaps better appreciated when it is remembered that a piece of 5-gauge rod weighing 150 lb. and having a length of 416 yds. will, when drawn into 20 gauge, be about 8 miles long; or, in other words, will have about thirty-five times its original length. And if by inter-annealing it is further drawn to 30 gauge, it will stretch to a length of 70 miles, or about 290 times the length

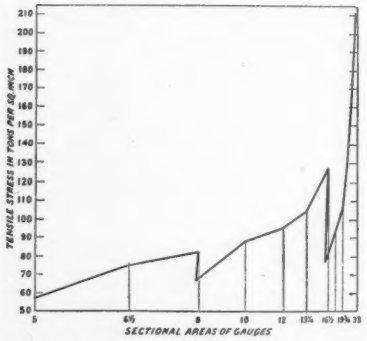


Fig. 5—Tensile strength curve of a hard steel wire drawn from 5 gauge (0.214 in.) untempered rod to 30 gauge (0.0214 in.) in 18 holes, tempered at 8 gauge (0.160 in.) and retempered at 16½ gauge (0.062 in.).

Hard steel, chemical analysis: Carbon, 0.750%; Silicon, 0.230; Sulphur, 0.027; Phosphorus, 0.010; Manganese, 0.560%.

of the hot-rolled rod. To stand such severe work both mild and hard steel must, necessarily, be of good clean solid quality.

Whilst there are a great number of mechanical variations in connection with wire-drawing machinery, essentially the principle consists in reducing the diameter of a rod or wire by pulling it through a conical hole. The diagrams Figs. 2 to 5 illustrate the changes which take place in the material as it passes from one size to the other. Fig. 2 shows the varying tensile strength of a piece of 5-gauge rod when being reduced to 33-gauge wire, with an inter-annealing at 16½

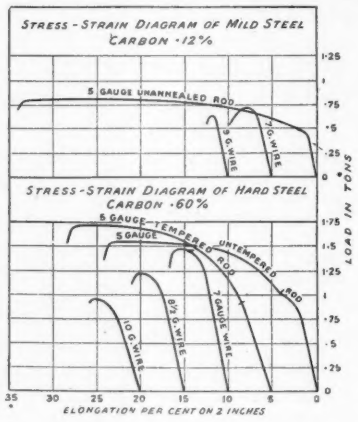


Fig. 6—Stress-strain diagrams for hard and soft steel wires.

gauge. It is interesting to note that the tensile strength runs up from 33 tons per sq. in. in the 5-gauge rod to 63 tons per sq. in. in 16½-gauge wire. Annealing at 16½ gauge brings the strength down to about 27 tons per sq. in., then when drawn from this gauge to 33gauge its tensile strength mounts up to 85 tons per sq. in. In Fig. 3 is shown a stress curve for a wire drawn from 5¾ gauge down to 14¼ gauge, and on this diagram an elongation curve has been plotted showing that in the passes given the elongation has fallen from about 33 per cent. to 3 per cent.

The diagram Fig. 4 shows the change in tensile strength and elongation when a heavy rod is reduced in six drafts. In Fig. 5 the curve indicates the variation in tensile strength of a 0.75 per cent., carbon steel wire when drawn from 5 gauge to 30 gauge. It will be observed that whilst the raw rod had a tensile strength of about 58 tons per sq. in., the finished wire has one of 210 tons per sq. in. The two gaps in the curve show the points at which tempering and retempering have taken place.

A study of the stress-strain diagrams (Fig. 6) of mild steel and hard steel clearly shows how rapidly the ductility of the material falls after being drawn from the raw rod in the case of mild steel, or from the tempered rod in the case of hard steel. The diagram for mild steel wire also shows that when the rod has been drawn into wire it ceases to have a definite yield point. This is also true for hard steel, both for the drawn wire and for the tempered rod before being drawn.

Flow of Metal in Drawing.—Before dealing with the defects in steel which cause trouble in wire-drawing, it will be well to consider the forces which act upon a piece of wire to reduce its diameter, and the kind of "flow" which occurs in passing through the hole in the drawplate. It will then be seen to what severe treatment steel is subjected in the process of wire-drawing.

Generally, it is considered that when a piece of rod is converted into a piece of wire its length is increased and its diameter reduced by stretching or elongating. However, what really happens when the rod is passing through the drawplate

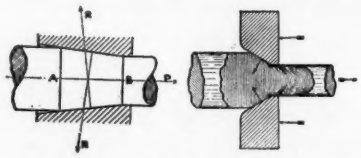


Fig. 7—Diagram showing the forces which act upon the shoulder when wire is being reduced.

Fig. 8—Section of plate and wire showing "planes" of flow.

is that the wire is assisted by the pull to stretch at any one instant over a very short length. The problem is not quite so simple as the statement seems to convey, as the "flow" of metal in travelling through the orifice is not the same character

as when a rod is either stretched or swaged to reduce its diameter.

Fig. 7 is a diagram illustrating the forces which act upon the wire rod as it passes through the plate. The force P represents the pull on the wire, and the forces R, R the resultants of the circumferential pressure upon the cone surface. It will be seen that the whole of the reduction from the larger to the smaller size takes place over the length AB. The problem then resolves itself into that of the flow of metal through a reducing orifice.

A peculiarity of wire-drawing is that the pressure which causes reduction is really due to the pull on the wire. It could not be done by pushing, as it would be almost impossible to

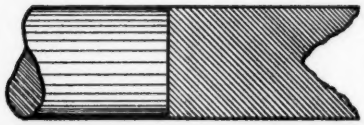


Fig. 9—Section of back end of 18 guage wire, showing the concavity induced when drawn from 10 gauge (X 15)

push a hard material through a conical hole on account of the enormous resisting forces set up. In the case of a pull, however, whilst the pressure on the shoulder may in some cases rise to as much as 150 tons per sq. in., there is no difficulty in drawing the wire through the conical hole, due to the fact that the pull simultaneously causes intense neck pressure, bringing about a local collapse of the material, thus assisting it to pass forward. This feature of the "flow" of the steel is illustrated by Fig. 8, and its mechanism probably is very much the same as that which happens in the case either of material or of living beings getting jammed in a tapered opening, in which it will readily be seen that further pressure on the back would but tend to increase the "jam" whereas releasing by a pull from the small side of the opening would reduce the pressure

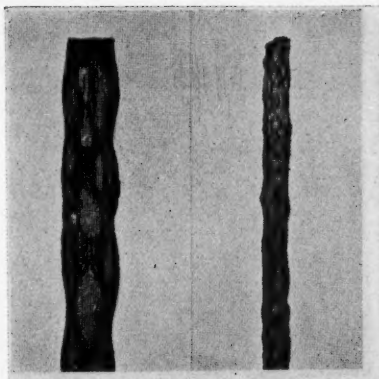


Fig. 11.—Charcoal iron wire rods made at Tintern Abbey Works about 1750. The larger rod is in process of being swaged down to the smaller one.

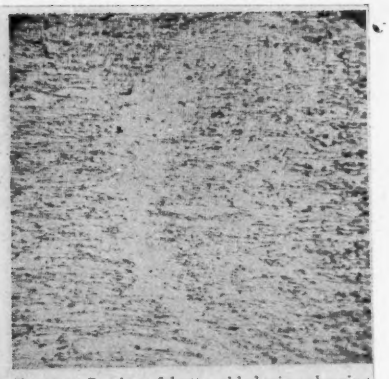


Fig. 12.—Section of butt-welded wire, showing relative movement of the carbonless "plane" when drawn from 5 gauge to 12 gauge. ×60.

and allow the "flow" to continue. By imagining the wire to be built up of an infinite number of planes at right angles to its axis, and considering what might happen to those planes as they pass through the conical hole, it may be conceived that the pull on the wire will tend to bulge forward the centre of the planes (as shown in Fig. 8), with the result that the middle portion of the material will always be moving slightly in advance of that which is nearer to the skin of the wire. This central collapsing, therefore, may be the real secret underlying the reducing of wire through a tapered hole.

The amount by which the centre moves forward in advance of the outside, it may be supposed, will vary with the kind of material and the percentage reduction of area. With very light drafting there will be need for the centre portion to move forward perhaps only a molecule or so in advance of the outside; but with heavy drafts the forward movement of the centre will be much greater. When the drafting is heavy enough to cause a pull which is almost equal to the breaking load of the wire, it can be imagined that there will be separation of the steel at its core, the same as in the fracture of an ordinary test-piece which is on the point of breaking in the testing machine. The results of various experiments and tests give support to the theory enunciated.

Dr. Horsburgh has already demonstrated[1] that if a fine hole be drilled at right angles to the axis of a wire and plugged with suitable material and subsequently drawn, the centre

Fig. 10—"Necking-down" caused by localised slag inclusions in wire. (3/5 natural size).

of the section moves forward slightly in advance of the two ends. Whilst this method no doubt illustrates the relative movement of the material, it is somewhat open to question on account of the alteration of the cross-section by drilling.

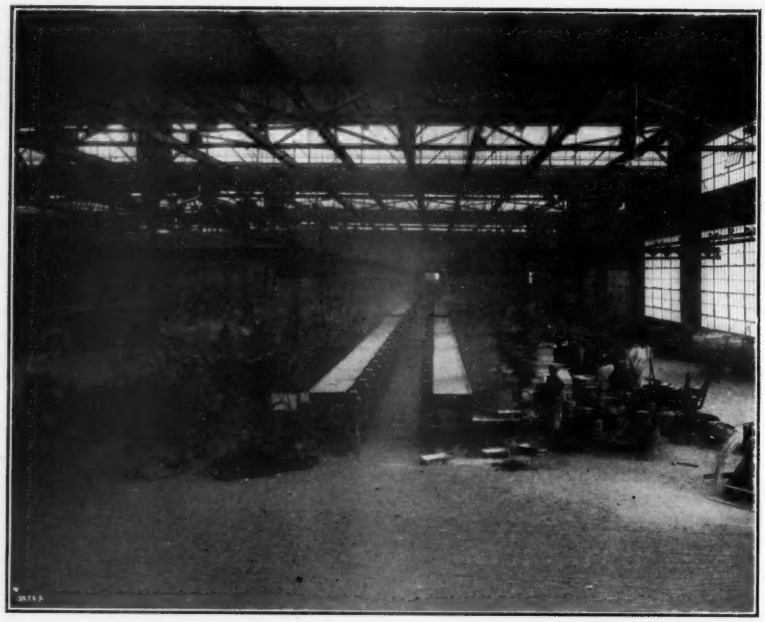
Another method of showing the relative "flow" of core and surface is to square carefully the back end of a piece of wire, and after drawing to note the depth of the concavity at the end of the wire. One such test is illustrated in Fig. 9. This shows a section of a piece of 18-gauge wire magnified fifteen diameters, which was reduced from 10 to 18 gauge in six drafts. After each draft the cup was gradually deepened. Several other tests with different sizes of wire and different methods of drafting gave con-

(*Continued on page 212*)

New Wire and Rod Mill

An account of the novel installations in the Sparrows Point plant of the Bethlehem Steel Co.

By George A. Richardson



General View Wire Drawing Department.

New Sparrows Point Plant Bethlehem Steel Co.

THE Bethlehem Steel Co. has recently completed and put into operation at its Sparrows Point, Maryland plant, a new rod and wire mill that is of the most up-to-date type, and embodies a number of new and interesting features. The rod mill is different from most others, in that it is entirely gear driven. Changes in the relative layouts of the different divisions of the plant, unusually high operating speed on the nail machines, and the long warehouse and shipping wharf running practically the entire length of the wire mill are among the other features. This series of articles describes in detail the chief characteristics of this new operation. The present installment deals with the wire drawing, barbed wire, nail manufacturing and galvanizing department. Some mention is also made of the bale tie department.

Wire Drawing Department

This department is housed in a building 150 feet wide by 300 feet long. The wire drawing equipment is of the latest type, the majority of the blocks being of the single-head, and a few of the double-head type. Each block is individually driven by a 20 H. P. D. C. motor with control gear for any speed between the limits of 50 and 150 R. P. M.

A feature of these wire drawing blocks is the safety device incorporated in each machine. Located on a corner of the machine, in line with the die, is a metal ring about eight inches in diameter, supported by an arm, hinged so as to throw backwards towards the die block. Connected to this hinged arm is a switch that opens or closes the motor circuit, depending upon its position. In operation the rod or wire is threaded through this ring, then through the drawing die and onto the drawing block. Should a snarl or a kink occur in the rod or wire as it leaves the paying roll, it is intended that it will catch on the ring, throw it back, open the motor circuit, thereby stop the motor, thus preventing accident to the machine or operator.

To facilitate the handling of wire coils in passing from one drawing block to another, stripping cranes and hoists, electrically operated, are provided. These are controlled by push-button stations carried on the end of downward projecting pipes discernible in the illustration. Expanding grapples slip down into the center of the wire reels, the grapples are distended and the entire coil stripped from one reel and placed upon the next block in one simple handling. The use of these cranes saves much

Nail manufacturing department.

time and the handling of the bundles is greatly facilitated.

Facilities are provided for drawing all sizes of wire from No. 15 B. & S. to ⅜″ diameter.

Pot Annealing Department

A section of the Warehouse and Rod Shipping Department is set aside for the annealing operation which contains fuel-oil fired annealing pot furnaces built to take annealing pots 36″ inside diameter by 7′6″ deep, each with a capacity of 5000 pounds of wire. Each annealing furnace is equipped with two oil burners, one at the top and one at the bottom. These are automatically controlled through pyrometers insuring a uniform anneal throughout. If the bottom or top of the furnace heats up too fast, the lower or top burner is automatically turned off. Soaking pits also form parts of the annealing equipment.

Straightening and Cutting Department

This work is done in a section of the warehouse by four electrically driven wire straightening and cutting off machines. The capacities of these machines vary from ¼″ diameter by 20 feet in length or shorter to ½″ diameter by 20 feet in length or shorter.

Nail Manufacturing Department

The building which houses this department is on the same type of construction as the building previously mentioned. It is 150 feet wide, 325 feet long and is provided with a wood block floor laid on concrete. A special nail die manufacturing room forms a part of the layout. Here are located the various machines and equipment for making the dies, and also for hardening them; an electric furnace being provided for heating. The layout of the machines in this room is unusually compact, the arrangement having been decided upon so the men can turn from one machine to another without walking far.

One hundred and thirty-nine nail machines adapted to making a wide range of standard sizes and varieties of nails form part of the equipment of the Nail Department. Several machines are provided for making standard staples. These are belt-driven, driven in groups from overhead line shafts. Each group line shaft is belt-driven by a fifty horse power motor.

The capacity of the nail manufacturing department is

Warehouse.

over 3,000 gross tons per month.

Nail Cleaning and Kegging Department

This department is part of the nail manufacturing department and comprises the rumbler charging floor, rumblers, various weight scales, etc.

Nails from the nail machines are lifted up in buggies to the rumbler charging floor by a five ton crane. The rumbler charging floor, built entirely of steel, is about ten feet eight inches above the main floor of the nail department. It is 36 feet wide by 75 feet long. At the entrance end is a five ton capacity platform scale on which incoming nails are weighed.

Beneath the rumbler floor are located the nail rumblers and the keg shakers which are driven by electric motors. There are eight 25-keg rumblers, each with four keg shakers and four ten keg capacity rumblers each with two keg shakers. The nail rumblers are elevated to allow the clean nails to fall from the rumblers on a steel plate platform, which the nails are scraped into the empty kegs in the shaking machine.

Nail cleaning and kegging department.

The kegs are then weighed and enough nails added to the keg to fill to the required weight. From this point the nails will go either direct to the shipping room, or to the assorting room to be assorted in preparation for galvanizing, cement coating or blueing. For weighing, six platform scales are provided on the floor, three on each side of the rumbler platform.

Serving the nail tumblers are two lines of 18″ wide belt conveyors for charging and two continuous bucket elevators to remove the dirty sawdust and whiskers coming from the tumblers in the cleaning operation. These bucket elevators load the refuse sawdust and whiskers into trucks provided for the purpose, from which

they are then loaded into railroad cars. The sawdust is separated from the whiskers in a sawdust separator and the latter are then shipped along with defective nails to the open hearth plant for re-melting.

An all-steel sawdust storage bin is located in the same building. It has a capacity of six carloads. The bin is charged by means of an exhaust fan and suitable piping for the railroad cars to the bin.

Two 18″ wide by 75 foot long and one 18″ wide by 105 foot long flat apron conveyors carrying filled kegs to the keg nailing machines and into the warehouse, avoiding handling labor.

All kegs are made in the cooperage plant adjacent to the

Barbed wire department.

nail department. Thence the kegs are carried by an elevator conveyor directly to the packing floor. Five standard sizes of kegs are used, viz. Diameters of 9½″, 10¼″, 11¼″ and 12″. The 12″ kegs are made in two lengths. 18″ and 20″. The cooperage shop has most modern machinery for rapidly assembling and completing kegs. A dry kiln forms part of the equipment.

Nail Assorting Department

Nails for cement coating, blueing or galvanizing are first carefully sorted, bad or defective ones being thrown out. This assorting is done entirely by girls working at 25 benches in the Assorting building, located in the Barbed Wire Building.

Cement Coating and Blueing Departments

A ten keg tumbler is installed for the purpose of manufacturing cement-coated nails.

A hot tumbler and necessary equipment provides the facilities for making blued or sterilized nails.

Equipment is also provided for galvanizing nails, this including hot tumbler, water tank, centrifugal dryer, etc.

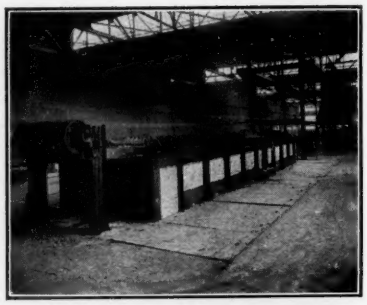
Bale Tie Department

In the Bale Tie Department, single loop bale ties are made from Nos. 13 to 16½ wire in lengths of from 7 to 13 feet. Two machines are in use each of which make five complete bale ties in one operation. There are ten operations producing 50 ties per minute. The ties are automatically counted and ejected from the machine in bundles of 250 each. The bundles are then wrapped at both ends with burlap and banded with wire, a metal tag showing the length and gauge of the wire being fastened to each bundle. The daily capacity of the department is 8-10 tons.

Galvanizing Department

The wire galvanizing department occupies another building, 350 feet long by 75 feet wide, of the same general type as the buildings already mentioned. The equipment consists of:

Two lead pan annealing furnaces, complete with depressor rolls and comb. These pans are 54″ wide by 15′ long and ten



Lead pans, galvanizing department.

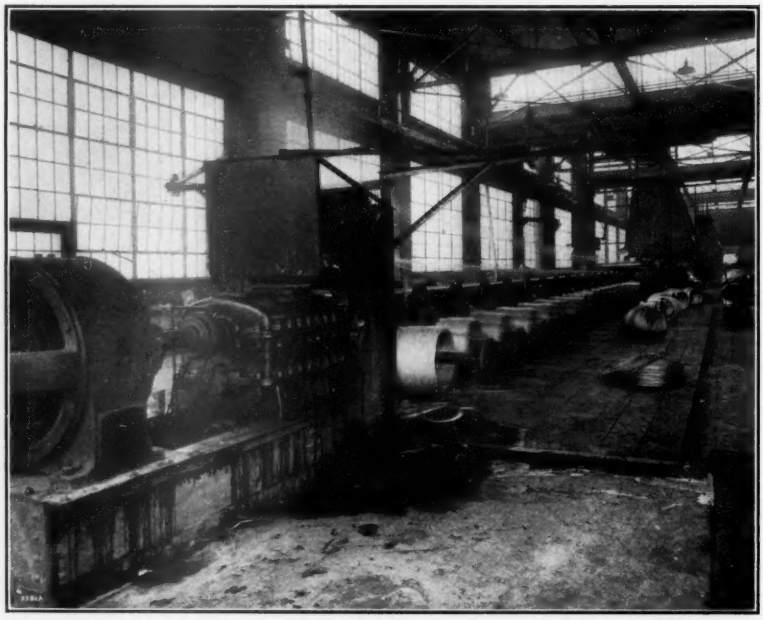
inches deep, and arranged for annealing 36 wires at one time. The length of the furnace is 40 feet and it is arranged for oil or coal fuel.

One galvanizing pan, complete with depressor rolls and wipers, 54″ wide by 24′ long and 22″ deep, arranged for galvanizing 36 wires at one time. Length of furnace 26 feet, arranged for oil or coal fuel.

One water quenching box used for cooling wires before they enter the granite pickling tank.

One granite pickling tank; one water wire washing box to wash acid off wire before it enters the granite flux box; one granite flux box; one inclined hat wire drying plate to dry wire before it enters the galvanizing tank; one inclined coke wipe, to wipe surplus spelter from each strand of wire as it

(*Continued on page 212*)



Take-up frames, galvanizing department.

Research on Mechanical Properties of Steel Wire

PART II. *

Recent investigations in Germany leading to methods for the more exact determination of drawing processes

By Dr. Ing. Wilh. Pungel

(Translated from Stahl v. Eisen)

Test Series: B.-Steel: 0.5, 0.4, and 0.24% C.

THE tests of Steel: B, C, D[1] were brief. All in all but eight coils were hardened as follows: four coils of Steel B

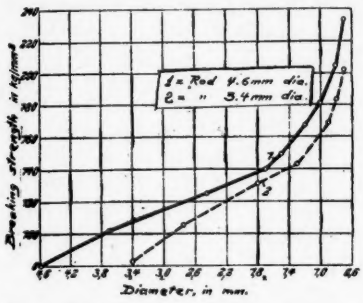


Fig. 8—Steel C. Change in breaking strength through cold working.

(original dia. 4.6, 4.2, 3.4, 2.6mm.), two coils of Steel C (4.6mm original dia.), and two coils of Steel D (original dia. 3.4mm). The wire was drawn with a reduction from draft to draft varying from 20-30%.

The shapes of the curves representing these three kinds of steels were the same as described in connection with Steel A, and the observations with respect to Steel C (see figure 8-12) were the same as those pertaining to Steel: B and D. As already mentioned in connection with Steel A, increasing diameter of the hardened wire resulted in a slight decrease in the tensile strength of the finished wire.

Flexure-Test

Table 4 indicates the flexure —and the tensile strength of several wires (original dia. 4.6 and 3.4mm). The figure very well illustrates the influence of carbon upon the flexion-test-numbers.

The flexion-test numbers increase as the carbon content of the wire increases. The flexion-test-numbers of wire which ranges relatively low as to tensile strength usually exceeds the flexion-test-numbers of wire of high tensile strength. Comparison betwen tensile strength and flexion-test-numbers (see table 4) shows that the latter increase as carbon content and tensile strength ascend. Hence, it is essential to always consider the substance and composition of the wire before interpreting the flexion-test-numbers. Experiments indicate that it is very possible that the flexibility of a given wire may well remain below the mark as indicated by its composition although it may comply with common specifications.

The second column of the table gives the flexion-test-numbers of hardened wire. It shows that wire which contains but a nominal amount of carbon is remarkable for great flexion-test-numbers, and that it loses this property in proportion to the increasing percentage of carbon. High flexion-test-numbers of hardened wire can not serve as a scale for measuring quality. The properties of the particular steel under consideration as well as the diameter play a determining part. Hence, close observation and accurate registration of the temperature of the hardening process is an essential factor in the manufacture of quality wire.

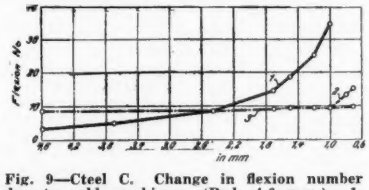


Fig. 9—Cteel C. Change in flexion number due to cold working. (Rod, 4.6 mm.) 1. Bending radius, 5mm. 2. Bending radius, 2.5 mm. 3. Bending radius, 2d.

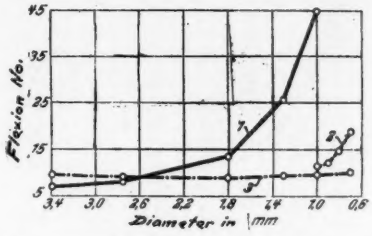


Fig. 10—Steel C. Change in flexibility through cold working. (Rod, 3.4 mm.) 1. Bending radius, r=5 mm. 2. r=2.5 mm. 3. r=2d.

Torsions

The percentage of carbon content does not have a great influence upon the number of simple torsions, for the latter increase but slightly while the carbon percentage may be falling off rapidly.

The constant-horizontal tendency of the curve (see figures 8-12) and its abrupt sharp decline are characteristic for Steel B, C and D. This sudden decline occurred in connection with Steel A at 90% average reduction (at 88% when "heavy

Table 4. Influence of carbon content.

Steel	Bending Test No. for rod	Diameter, Bending test no, and Tensile strength of wire.									
		2.5 mm		2.0 mm		1.6 mm		1.5 mm		1.2 mm	
		Flexion no.	Tensile kg/mm²	Flexion no	Tensile kg/mm²	Flexion no	Tensile kg/mm²	Flexion no	Tensile kg/mm²	Flexion no	Tensile kg/mm²
		Rod, 4.6 mm dia									
A	3,0	8,5	149	14	165	18,5	183	20,5	189	31	223
B	3,5	9,0	137	14,5	155	18,5	170	20,0	173	32	201
C	3,5	8,5	124	12,0	134	16,5	145	18,5	150	25	167
D	5	8	100	11,0	108	15	115	17,0	117	23,5	131
		Rod, 3.4 mm dia.									
B	5	9,5	114	13,0	131	19,0	148	22	152	32	166
C	7	9,5	112	12,5	126	18,5	136	21	138	32	150
D	7–8	9,5	83	11,5	100	16,0	110	18	113	23,5	124

*For Part I see Wire & Wire Products p. 156, May, 1927. 1. For carbon content see Part I.

drafts" were employed and at 92% when "light drafts" were applied). The declining-point for the other test-steels run as follows: Steel: B at 93% reduction; Steel: C at 94-95% reduction; and Steel: D at 96-97% reduction. All torsions are even and uniform up to this point, while the wire turns brittle and shows uneven torsion as soon as

Table 5. Influence of carbon content on alternate torsion of wire rod.

Stahl	Kohlenstoffgehalt %	Hartedraht 4,6 mm ① n	Hartedraht 4,6 mm ① σ_B kg/mm²	Hartedraht 3,4 mm ① n	Hartedraht 3,4 mm ① σ_B kg/mm²
A	0,62	76	101	—	—
B	0,50	110	91	172	93
C	0,41	180	80	218	82,5
D	0,24	410	57	507	61

Stahl; steel. Kohlenstoffgehalt: carbon content. Hartedraht: wire rod. Values in columns 3 and 5 represent torsion numbers, those in 4 and 6, tensile strength.

the reduction exceeds this point. In other words, the declining point indicates the limit up to which wire may be drawn without ill-effect upon its flexibility and tensile strength. The torsion-numbers for Steel: B, C and D are the same as described in connection with Steel: A. All the curves fall off in proportion to the decreasing diameter of the wire under consideration. It should be noted, however, that wire which has been drawn from rod of small initial diameter registers with a relatively greater number of torsions than wire of the same tensile strength that has been drawn from rod of greater diameter.

Table 5 shows the torsion-numbers (n) and the tensile strength of 4.6 and 3.4mm. wire of Steel: A, B, C and D.

Table 6 compares wires of equal torsion-numbers and equal

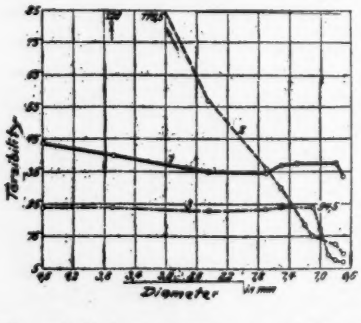


Fig. 11—Steel C. Change in torsibility through cold working. (Rod, 4.6 mm.) 1. Simple torsibility; 2. Alternate torsibility; 3. "Long loop"; length of specimen l=100d.

tensile strength which have been drawn from Steel: A, B, C and D. Column 1 stands for finished wire and column 3 for hard or unpatented wire, and the tensile strength is registered at the top of the column, while column 4 represents the torsion-numbers. Comparison makes it evident that Wire: A which contains the highest percentage of carbon also registers with the highest torsion numbers, the latter being 50-100% superior to the less carbonized wires B and C.

Algebraic Determination of the Manufacturing Procedure for Steel Wire

Algebraic methods of determining the diameter of rod needed for the manufacture of finished wire of specified tensile strength and fixed diameter are but infrequently applied, although they require but little time and could easily be employed by the managing-engi-

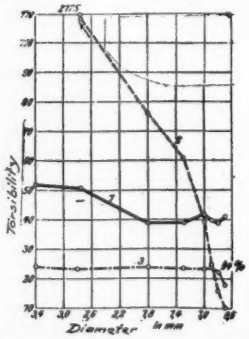


Fig. 12—Steel C. Change in torsibility through cold working. (Rod, 3.4 mm.) 1. Simple torsibility; 2. Alternate tors. 3. "Long loop" Length of specimen, l=100d.

neer. Even today it seems to be the practice in some plants to choose the diameter of the hardened wire according to "experience" which has been gathered from previous experiments with steel wire of "almost" the same properties.

Karmarsch[7] devised a practical formula which is well suited to calculate the tensile strength of finished wire. He estimates the tensile strength (f) per kg. of wire of diameter: dmm. as follows:

$$f = a.d^2 + b.d$$

The symbols (a) and (b) stand for the so called "characteristic-values" which vary

7. K. A. Seyrich: Dissertation Dresden, 1911.

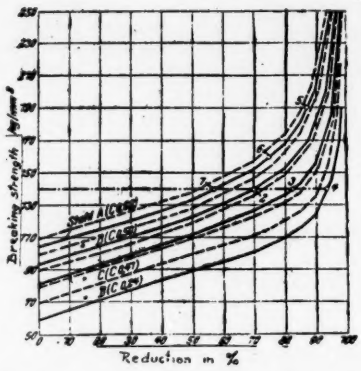


Fig. 13—Change in breaking strength in relation to percent reduction.

for annealed and cold drawn wire. Seyrich[7] established a fixed relation between the tensile strength of hard and finished wire. The graphic illustration of his formula (see Figure 14) is a hyperbola. The abscissa represents the wire-diameter and the ordinate the tangential values of the curve. His formula reads as follows:

$$F \cdot \tan\alpha = 54.7 = \text{constant}.$$

In other words the product of wire cross section times increase in tensile strength caused by drawing is constant. It has already been pointed out that a "certain" reduction always will result in a "certain" tensile strength, that is to say, the relation between decrease in section and tenacity of the finished product does not fluctuate.

This observation—it has been confirmed by Goerens[3]—supplies a simple means of determining the rod which is needed to secure a finished wire of fixed measurements. Table 7 gives the final tensile strength of wires (Steel: A, B, C and D) whose original diameters have been reduced 30; 40; 50; 60; 70; and 80% respectively.

The curves of Figure 13 are based upon above observation. The point of intersection of each individual curve and the ordinate indicates the average tensile strength of wire rod or wire. The graph indicates that it ranges slightly higher for light wire than for heavy wire. These deviations, however, are but slight and do not affect calculation.

3. Ferrum, vol. 10 (1912-13) p. 65.

To produce a finished wire of fixed measurements one simply analyzes one or two sample pieces of the patented wire, or determines the tensile strength of the rolled wire.

Let us assume the wire is of Steel: B and that it should be reduced to 2.2mm wire with a tensile strength of 140 kg. per mm². The average tensile strength of the patented wire is 95kg. per mm². To determine the proper operation (see diagram 13) one draws through point 140kg per mm² a parallel to the abscissa. This line intersects curve B in point 2. The reduction in diameter for this point is 70%. Hence, the diameter has to be reduced 70% (only in connection with Steel: B) in order to secure a tensile strength of 140kg. per mm². The proper diameter of the rod may be calculated from the cross-section-formula:

Zahlentafel 6. Querschnittsabnahme und Dauerwechselzahl bei Stählen gleicher Festigkeit und gleichen Enddurchmessern.

Stahl	110/130 kg/mm²				130/150 kg/mm²				135/145 kg/mm²				140/160 kg/mm²				150/165 kg/mm²				160/175 kg/mm²			
	Fertig-draht ⌀ mm	Quer-schnitts-abnahme %	Härte-draht ⌀ mm	n	Fertig-draht ⌀ mm	Quer-schnitts-abnahme %	Härte-draht ⌀ mm	n	Fertig-draht ⌀ mm	Quer-schnitts-abnahme %	Härte-draht ⌀ mm	n	Fertig-draht ⌀ mm	Quer-schnitts-abnahme %	Härte-draht ⌀ mm	n	Fertig-draht ⌀ mm	Quer-schnitts-abnahme %	Härte-draht ⌀ mm	n	Fertig-draht ⌀ mm	Quer-schnitts-abnahme %	Härte-draht ⌀ mm	n
A	2,8	23,6	3,2	97	2,4	43,7	3,2	76	2,2	62,6	3,6	46	1,9	72	3,6	42	1,6	75	3,2	66	1,4	81	3,2	42
B	2,8	55,5	4,2	56	2,4	67,6	4,2	39	2,1	78	4,2	23	1,9	79,5	4,2	28	1,6	85,6	4,2	26	1,4	89	4,2	25
A	2,7	28,6	3,2	95	2,2	58,2	2,8	86	1,8	69	2,8	65	1,5	70,5	2,8	45	1,3	79	2,8	30	—	—	—	—
C	2,7	55,5	4,6	60	2,2	77,5	4,6	30	1,8	88	4,6	39	1,5	89,5	4,6	30	1,3	92	4,6	22	—	—	—	—

Table 6—Reductions and alternate torsibility of steel wires of equal tensile strength and final diameter. Column 2: Finished wire diameter; col. 3: reduction; col. 4: rod diameter, etc.

Stahl	Festigkeit am Härtedraht kg/mm²	Quer-schnitt-verminderung 30 % kg/mm²	40 % kg/mm²	50 % kg/mm²	60 % kg/mm²	70 % kg/mm²	80 % kg/mm²
A	105	121	127	133	142	152	168
B	94	110	115	120	129	139	153
C	82	100	106	112	120	127	136
D	59	77	83	89	95	101	110

Table 7—Relation between tensile strength and reductions and carbon content. Col. 2: tens. strength of rod. Cols. 3-8. tens. strength of wire corresponding to percent reductions.

$$R\,\% = \frac{\frac{D_0^2\pi}{4} - \frac{D_1^2\pi}{4}}{\frac{D_0^2\pi}{4}} \cdot 100$$

D_0=diameter of rod
D_1=diameter of finished wire

$$D_0 = 10 \cdot D_1 \cdot \sqrt{\frac{1}{100 - R}}$$

D_1. and R. being known, D_0 may be calculated.

Substituting actual values from the example (R=70%, D_1=2.2mm) we arrive at the following formula:

$$D_0 = 10 \cdot 2{,}2 \sqrt{\frac{1}{30}}$$
$$= 10 \cdot 2{,}2 \cdot 0{,}182 = 4{,}0 \text{ mm.}$$

Hence, the process has to begin with a diameter of 4.0 mm.

Computation of the tensile-strength-test-curves provide a convenient means to determine the most advantageous wire-material for a given purpose. In the case under consideration (see figure 13) the horizontal line is drawn through 140 kg. per mm² and intersects the curves in point 1, 2, 3 and 4.

The calculated reductions may be seen from Table 8.

Steel: A requires the least cold working for wire of the above specified tensile strength. It is advisable to choose this steel whenever a high-quality products, such as wire-rope or hoisting-wire, is demanded as it has excellent flexibility and high torsion-test-numbers. Cost of raw material, hardening expenses, and wages, should always be considered if the occasion calls only for the ordinarily traded merchandise.

Figure 14 simplifies the determination of the proper rod diameter. The individual curves have been plotted according to the following formula.

$$D_0 = 10 \cdot D_1 \sqrt{\frac{1}{100 - R}}$$

The ordinate represents the diameter of the rod and the abscissa the diameter of the finished-wire. One example may illustrate the efficient use of the curves. Let us assume that we are to produce a finished wire of 1 mm. from Steel: A which has to have a tensile strength of 190 kg. per mm².

From Fig. 13, a tensile strength of 190 kg. mm² for Steel A corresponds to a reduction of 87%.

In order to determine the diameter of the rod one erects in Fig. 14 a perpendicular (B-C) upon C. (finished wire 1.0 mm. dia.) which intersects the curve representing 87% in X., and read the diameter (in this specific case 2.8) from the ordinate.

Table 8.—Calculated Reductions and Rod diameters.

Steel	Reductions %	Rod diameter mm.
A	57	3.4
B	70	4.0
C	83	5.4
D	94	8.8

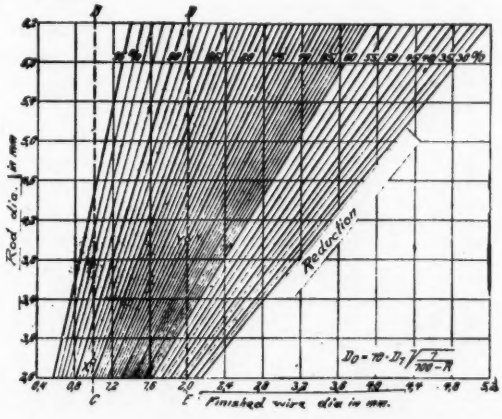


Fig. 14—Diagram for determination of rod diameter.

Summary:

Several steels of various carbon content were tested as to the influence of drawing upon their tensile strength and as to the influence of the varying carbon content upon their flexibility. The following results were arrived at:

1. The flexibility increases as the carbon content decreases. Soft steel permits extensive diameter reduction, yet, furnishes wire of undiminished flexibility.

2. The tensile strength of

(*Continued on page 211*)

New Developments in Copper Wire Drawing

PART II

Results of experimental study of various phases of copper wire drawing.—The practice adopted in the Chicago mill of the Western Electric Co.

By John R. Shea and Samuel McMullen

Western Electric Co.

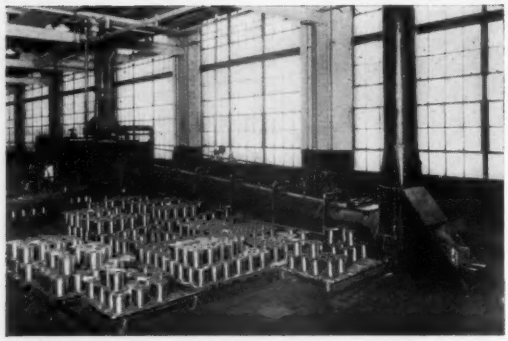
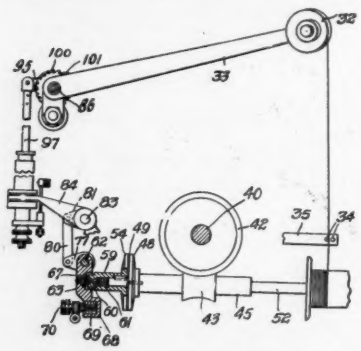


Fig. 24. Steam-seal annealing Furnace.

General Plant Features

THE present connected load of the motors in the rod and wire mill is about 6000 horse power for which it was necessary to enlarge the factory power plant. A 700-ft. tunnel connects the power plant with the rod and wire mill in which are laid pipes for carrying hot and cold water, steam, gas, and air and lead covered power cables.

The basement under the rod mill houses the electrolytic equipment, control boards for the roughing and intermediate mills, pumps for cooling water, and exhaust fans connected with an air washer for removing the fumes from the rod mill. A tunnel which passes beneath the intermediate and finishing mills connects with a room which houses the drives for the four rod coilers, the coiler control boards, the finishing mill control board, and the main power panel. In the wire mill basement are six large tanks which hold the compound used to lubricate and cool the wire-drawing dies. This compound is supplied under pressure to the wire-drawing machines on the floor above and returns by gravity.



All the wire-drawing machines are controlled by push buttons mounted on the machines, which connect with compensators in the basement. The 100-h. p. motors driving the large wire drawing machines are mounted in a tunnel and are connected to the machines above by chain drive.

This arrangement permits accessibility for maintenance of the electrical equipment with a minimum of interference to production, prevents the wire-drawing operators from having access to the electrical equipment and reduces accident hazard to a minimum.

Developments in Wire-Drawing Equipment and Methods

The rod and wire mill just described was designed following a comprehensive survey of wire-drawing processes and equipment used in this country and abroad. In connection with these studies, extensive laboratory investigations were undertaken relative to the characteristics of different types of commercial machines especially from the standpoint of operating efficiency, investment and floor space requirements. As a result of these investigations, it developed that marked improvements could be effected if wire could be produced commercially at higher machine speeds and with more compact machine equipment.

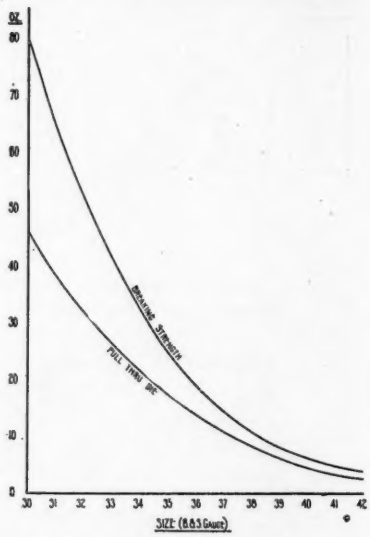


Fig. 15

While the design of the drawing mechanism in the new machine was very important, it was also essential that the finished wire be taken up on spools instead of coils. After considerable experimental work, a sensitive take-up device was developed to permit spooling at a constant drawing speed.

This spooling mechanism is illustrated by Fig. 14 in which the spool spindle is driven by a slipping clutch member con-

trolled through a tension arm, on which an idler pulley is located over which the wire passes on its way from the drawing capstan to the take-up spool. The take-up mechanism rotates the core of an empty spool at a speed synchronous with the speed of the wire as it leaves the drawing capstan. As the spool fills and the speed tends to increase, the wire on the tension arm tightens and compresses the tension arm against a spring adjusted for the proper gage of wire. This in turn reduces the pressure of the clutch driving the take-up spindle permitting the spool of wire to readjust its speed.

This device is extremely sensitive as illustrated in the drawing of No. 42 B. & S. wire at 2000 ft. per min., in which case the control arm must be adjusted to operate between 90 and 150 grams, since the pull required is 87 grams and the breaking strength of the wire is 170 grams. This device is so flexible that it can be adjusted to a drawing tension of

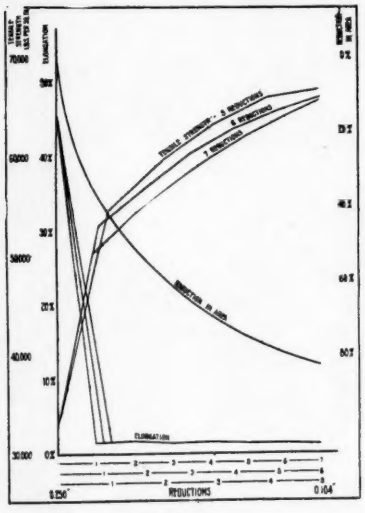


Fig. 16

from 9 pounds for No. 25 wire to 3 ounces for No. 42 wire. Fig. 15 illustrates its operating range on wire sizes No. 30 to No. 42, showing the gradual narrowing of the limits as the sizes decrease. A larger machine used for drawing loop cable wire from No. 18 to No. 30 B. & S. gages contains a similar mechanism.

The use of this sensitive device and a clutch which would slip without overheating as the spool filled, together with improvements in the wire drawing compound and the shape and quality of the diamond dies later described, permitted the drawing of wire at speeds ranging from 2000 to 3000 ft. per minute.

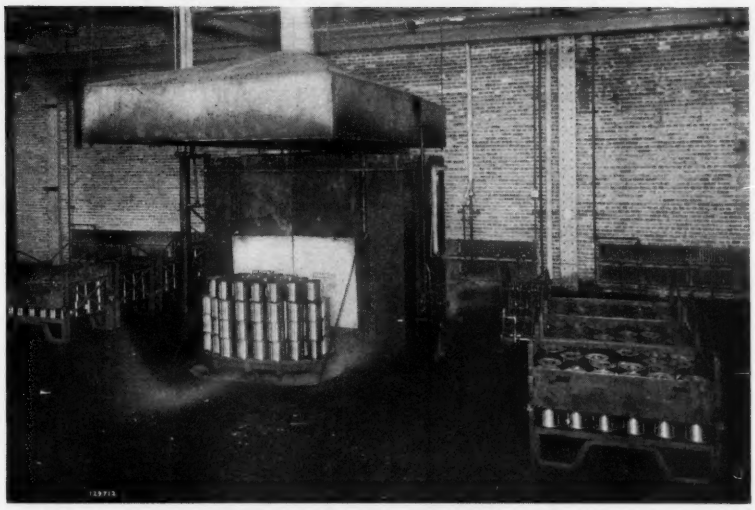


Fig. 23—Water-seal annealing furnace.

Wire Drawing Compound

At low speeds it was discovered that the compound for lubricating wire-drawing dies required little attention but as the speeds were increased the necessity for close analytical control was evident. The compound consists of an emulsion of soap, tallow, and water, the percentage of the soap and tallow being varied depending upon the size of wire and type of machine on which it is used.

It is important that the degree of "emulsification"[5] be carried far enough to break the tallow into particles about one micron in diameter, so that the material will stay in suspension in the water. If the tallow content is increased beyond a certain point it holds in the suspension in the solution a large amount of the copper dust which flakes off in a very fine state during the wire-drawing operation and this clogs the dies and causes breakage during the wire drawing. Ordinarily this copper dust settles out of the solution while in the large cooling tanks and a considerable amount is salvaged in this manner.

5. "The Theory of Emulsions and Emulsifications," W. Clayton.

Effect of Drawing on Copper

Tests were made to determine if the drawing of the smaller cable and all magnet wire sizes[6] in Brown & Sharpe (A. W. G.) steps was obtaining the maximum reduction possible per die. These tests showed it was feasible to make much heavier than A. W. G. reductions, at the first draft when annealed wire or soft copper rod was being drawn. It also showed that the elongation[7] of the rod or annealed wire was rapidly reduced to

(*Continued on page* 204)

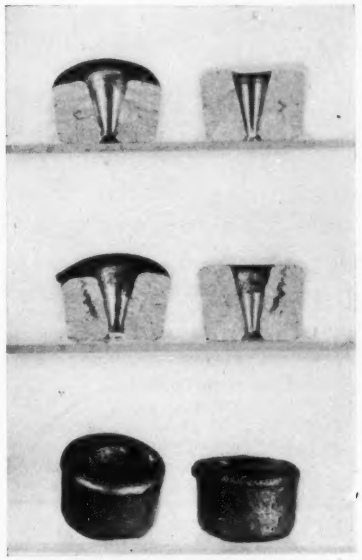


Fig. 20—Dies used for drawing line and heavy-gauge wire.

6. A. W. G. ("American Wire" or "Brown and Sharpe" gage) reductions are not used in converting the rod to line wire; these are generally specified in B. W. G. and N. B. S. gages.

7. See Figures, 16, 17, 18, and 19 showing the elongation of the rod or wire dropping to about 1½ per cent at the first die reduction and remaining practically constant.

Sleeper & Hartley
TRADE MARK
REG. U.S. PAT. OFF. & PRINCIPAL FOREIGN COUNTRIES

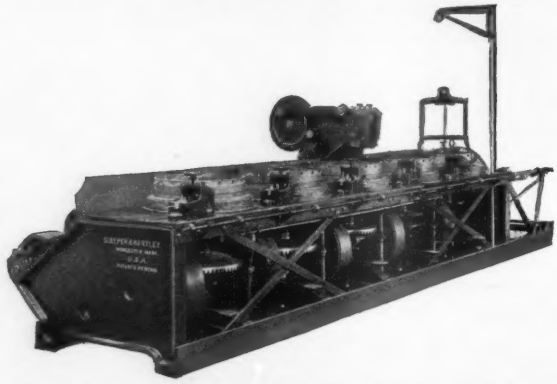
Practical Continuous Wire

These Machines Go Into Production at once—

Rod Frame

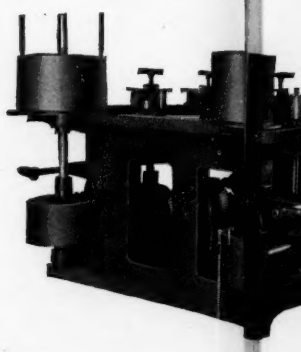
(No. 5—14 or 15 wire)
Patented June 3, 1924—May 12, 1925—others pending

All Ball or Roller Bearings
No Differential Gearing.
Automatic Compensation for Speeds of Heads.



Double 5-Draft Dry,

No. 14 to No. 23. [illegible]h or
3 to 4 Blocks to verag
No. 14 to 19—4 h[illegible] 1400
No. 14 to 20—5 h[illegible] 1100



Spring Coiling Machinery

of every description.

For example, we offer:

Universal Spring Coiling Machines

in ELEVEN Sizes

handling oil-tempered wire from .004" to ⅝" diam. These machines produce spring forms as illustrated herewith at very high productive speeds.

Patented

AGENTS: CHICAGO TERRITORY,
Neff, Kohlbusch & Bissell, Inc.

SLEEPER & HA

FOREIGN AGENTS AND REPRESENTATIVES: UNITED KINGDOM—Mr. Fredk. A. Perry, 63 Queen Victoria St., London. E. C. 4. FRANCE—Mr. Edgar Bloxham, 12 Rue du Delta, Paris. BELGIUM—Isbecque, Todd & Cie., 25-27 Boul. Emile Bockstael, Brussels.

WORCESTER MA

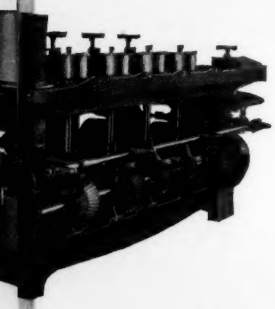
ire Drawing Machinery

Sleeper & Hartley TRADE MARK

ce—Reducing Overhead-Increasing Production!!

Dry, Intermediate

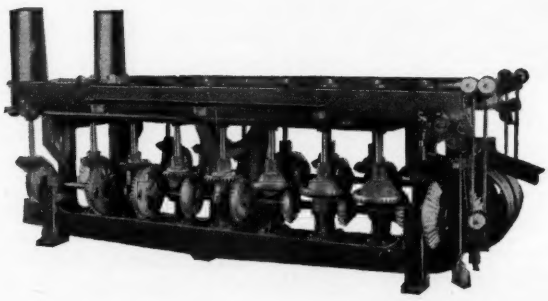
h or low carbon wire.
verage Operator.
1400 lbs. per block.
1100 lbs. per block.



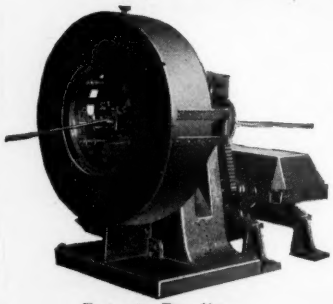
Double 8-Draft Fine Wire: Wet

No. 22 to 36. High or low carbon wire.

6 Blocks to Average Operator, 22-33, 8-hole, 660 lbs. per day of ten hours.



ARMORING MACHINES FOR "BX," PARK CABLE MOTOR WIRES, HOSE Etc., Etc.



Patents Pending

High Productive Speeds

LOCK WASHER MACHINERY

with Enormous Output

HIGH SPEED STRANDING MACHINERY

IARTLEY, Inc.

Agents: Philadelphia Territory
Swind Machinery Co.

ITALY—Henry Coe & Clerici, Milan. AUSTRALIA AND NEW ZEALAND—Edwin Wood Pty., Ltd., Melbourne.
JAPAN—Andrews & George Co., Tokyo. SWEDEN AND FINLAND—Akt., Rylander & Asplunds, Stockholm.

RMASS., U. S. A.

EDITORIAL · IMPRESSIONS

Control

IT is a healthy symptom in an old industry that for a long time, has operated on its traditions and individual "experience," when it manifests a tendency towards greater uniformity and greater control of manufacturing processes. Possibilities in the latter direction are unlimited in the wire industry where there is still much to be learned about the influence of essential factors in the composition of the metal, in drawing and heat treating.

The growing practice in the thorough examination and recording of the metal from billet to drawn wire is witness to the attempts at greater and more scientific control of wire drawing. The mechanical testing and photomicrography of wire, of course, plays an important part in this work. So much so, that there is at present a lively dispute over the most effective means for testing wire.

At the recent meeting of the Iron and Steel Institute in London, the reading of a paper by E. A. Atkins and the subsequent discussion disclosed much valuable work being done in England particularly in the testing and metallurgy of iron and steel wire. We publish the first part of Mr. Atkins' important treatise on page 187 of this issue.

Among other points the question of the relative merits of torsion and bending tests for wire was raised. English authorities, said Prof. Louis at the Institute meeting, prefer the torsion test while German experts incline in favor of alternate bending tests. In this connection our readers will find valuable data in the the article of Dr. Pungel in the May and the present issues of Wire & Wire Products. Dr. Pungel has made interesting use of both alternate torsion and alternate bending tests.

The work of Mr. Atkins is particularly impressive in its emphasis on the importance of cooperation between the wire drawer and steelmaker. The study of the influence of inclusions in the steel on the mechanical properties of the finished wire should afford valuable data for more exact specifications for the steel. In Mr. Atkins' works specially trained inspectors keep complete records of microscopic examinations of the metal in the rod and wire mill.

Such scientific control is an essential requisite in the elimination of waste and the improvement of the product.

Standards

INTO standardization the best forces of an industry must enter: cooperation, simplified practice, and uniformity in cost accounting. In discussing the best needs of the industry the representatives of the trade will unavoidably fuse the best in their experience, with the result that the final standards of manufacture will not only represent the coordinated result of the past practice but a genuine advance beyond that practice. Cooperation in industry inevitably leads to the establishment of standards, just as any attempt at standardization involves cooperation.

The recent work of the Department of Commerce in sponsoring the movement towards standardization of reels and spools serves as an excellent illustration in point. The council which drew up the standard specifications represented the best authorities in the field and their suggestions will go far towards increased efficiency and simplicity.

Much could be done by similar standardization in testing procedure and cost accounting. The former would mark a great improvement in specifications for wire rod or billets, and lead to better understanding between the wire mill and the rod or billet mill.

While the latter would be of particular advantage to the fabricators who are notably irregular in their cost accounting. Uniformity would mean a more stable business and greater assurance against loss. Some time ago we commented in these columns on the deplorable instability in the spring making trade resulting from unstandardized cost estimates. Here as well as in other departments of the wire industry simplified practice could be applied to great advantage.

WIRE
& WIRE PRODUCTS

British Trade

AMERICAN manufacturers have been watching with a great deal of interest the status of the wire industry in Great Britain. Since the coal strike the iron and steel wire trade, like other iron and steel industries, has been dependent on foreign manufactures. The British industry, however, is rapidly recovering. With the exception of miscellaneous wire manufactures all April imports showed tonnages below those recorded for March.

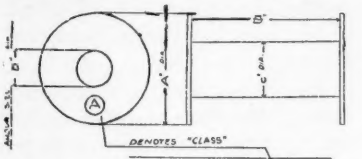
However, exports declined considerably from March to April.

The reports indicate that the British trade is apparently returning to its normal activity, with productions slowing down from the extreme activity which had characterized it, since the ending of the coal strike. As we go to press, no statistics are yet available on the influence of this recovery on export trade of the United States. Data of exports to the United Kingdom indicate a marked increase in March over February especially in woven wire, fencing, plain wire, insulated wire and wire nails.

Standardization of Reels and Spools

RECENTLY representatives of some of the largest manufacturers of wire and wire drawing equipment met under the auspices of the United States Department of Commerce for the purpose of drawing up specifications for the standardization of spools and reels. The recommendations of this committee is intended to affect only new production and equipment, and no interference with the proper functioning of existing equipment is contemplated or implied. By making the schedule progressively more effective during the period of transition from present to simplified practice, it should be possible to bring about the change with little or no inconvenience to any concerned.

For a long time the producers and users of metal spools and reels have sustained an appreciable amount of confusion, due to the great variety of sizes and dimensions that characterize these articles. Both these elements in the industry coincidentally requested the Department of Commerce to cooperate with them in the matter of reducing the prevalent diversification to a practicable minimum. The preliminary conference which was held on Dec. 2, 1926 represented over 85% of the annual production of reels and spools.

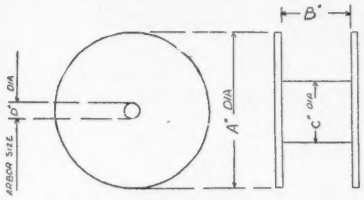


Pounds of Copper Wire Spool Will Carry	A (in inches)	B	C	D	Capacity In Pounds Theoretical	Less	Equals	Class A Permissible Variation in Weight	Class B
1#	2	2"	1	5/8	2.07#	48%	1.07#	± 1%	± 5%
2#	2½	3	1	5/8	3.95#	48%	2.01#	± 1½	± 5%
3#	3	3	1¼	5/8	6.61#	48%	3.39#	± 1½	± 5%
5#	3½	3	1½	5/8	9.52#	40%	4.39#	± 1½	± 5%
10#	4½	4	1½	5/8	17.28#	40%	10.37#	± 1½	± 4 ½
25#	6	10	2½	5/8	41.15#	40%	24.67#		± 4 ½
50#	8	6	5	3/4	82.99#	40%	49.79#		± 4 ½
100#	10	7	4	3/4	167.84#	33-1/3%	98.52#		± 4 ½

Annealing, Handling and Shipping Spools for bare copper wire.

The general conference which was held on March 30, 1927, at the Department of Commerce drew up a set of recommendations to be referred to the trade at large. In formally presenting the tentative program for the conference for discussion, the Chairman of the simplified Practice Committee stated that the three tables of sizes recommended concerned annealing, take-off, and shipping spools and reels for bare wire. He said further:

From personal experience I know that the trade carries a good many sizes that could be eliminated. The mills, concurring in this belief, are convinced that certain sizes could be deleted if their customers were shown the general advantage of confining their normal requirements to a practicable minimum number of sizes. The Simplified Practice Committee realizes that one factor that governs the dimensions of spools is the weight of wire coiled thereon. For example, a customer might buy his spools in groups. The spools in such a group or set may carry 5, 10, 25, 50 and 100 pounds of wire, respectively. The volume carried by each spool is determined by obtaining the proper ratio between the three dimensions, (i. e. barrel diameter, traverse and flanges).

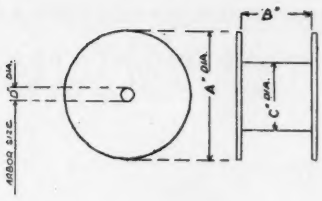


A	B	C	D
18"	8"	7"	1¼"
24"	10"	12"	1¼"
30"	10"	14"	1¼"
36"	14"	14"	1¼"

Take off reels.

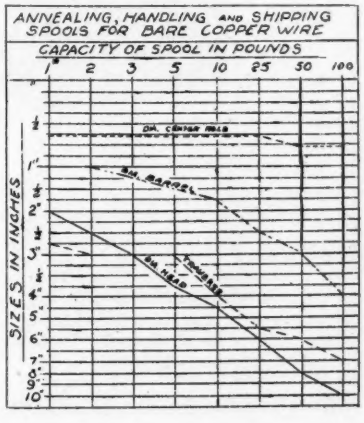
For purposes of economy we would like to have as small a barrel as possible in existing circumstances, because the barrel bounds unused space and increases the cubic contents of a case in shipment. However, this desire must be reconciled with the needs of the wire manufacturers and others users of spools and reels who have matters of machine speeds, and interchangeability to consider. There is a minimum limit in barrel diameter below which the operations of coiling and uncoiling cannot be negotiated satisfactorily. Therefore, the Simplified Practice Committee has suggested only those barrel diameters which represent the average dimensions in major demand. The same may be said of the other dimensions.

While it may not be possible for this conference to settle all the points involved, it is true that a good start will have been made if we do nothing more than establish a simplified list of spool capacities. The dimensions of the spools themselves as well as other aspects of the problem could with profit, be



A	B	C	D	CAPACITY IN POUNDS THEORETICAL	LESS	EQUALS
16"	6"	8"	1¼"	386#	33⅓%	245#
18"	10"	12"	1¼"	451#	33⅓%	301#
21"	10"	13"	1¼"	684#	33⅓%	457#

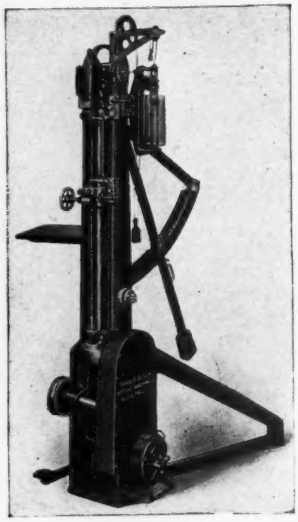
Annealing reels.


ANNEALING, HANDLING AND SHIPPING SPOOLS FOR BARE COPPER WIRE
CAPACITY OF SPOOL IN POUNDS
1 2 3 5 10 25 50 100
SIZES IN INCHES
DIA. CENTER HOLE
DIA. BARREL
TRAVERSE
DIA. HEAD

Olsen Vertical Autographic Pendulum Type

WIRE TESTER

Made in capacities from 50 lbs. to 1000 lbs.



This illustration is of the very latest up-to-date Autographic Wire Tester which will scribe the stress strain diagram on square cross-section paper, correcting for the sine angle of the pendulum to magnify the elongation of the wire ten times. The autographic record may be taken directly from the wire, and thus the greatest of accuracy secured in such a record, as we do not consider any autographic record or wire test as satisfactory or acceptable taken from the motion of the heads of the testing machine.

Olsen Autographic Wire Testers can also be secured of capacities from 10,000 lbs. up to 1,000,000 lbs. capacity for testing steel, copper or brass wire of all gauges, as well as the largest wire rope made.

Also manufacturers of Olsen Static-Dynamic Balancing Machine equipment for balancing high speed rotating parts, which will eliminate vibration and increase efficiency and production of all high speed machinery.

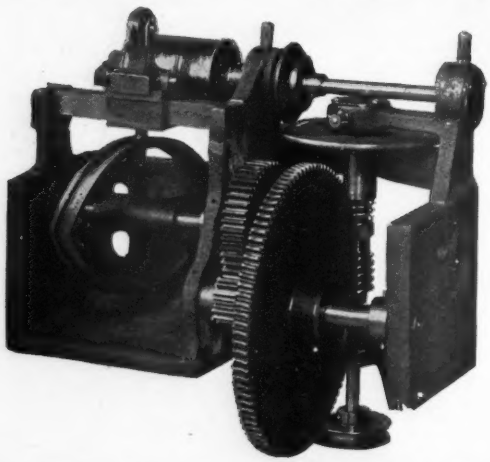
Manufactured by

TINIUS OLSEN TESTING MACHINE CO.

500 North 12th St., Philadelphia, Pa.

Spooling Attachment

Spools wire from .018 to .003 **Dimensions 12"x12"x15"**
Weight Approximately 50 lbs. **Ball bearing equipped**



The above illustration shows an open view of our No. 1 Spooler. All gears are enclosed.

Uniform tension and lay of the wire on the Spool is assured by the use of a screw cam. It is inexpensive, simple to operate and can quickly be attached to any machine.

CYRUS CURRIER & SONS

365 Market St. **NEWARK, N. J.**

referred to some sort of continuing committee of the industry.

The ensuing discussion, supplemented by a great many letters received from men in the industry who were unable to be present, concerned itself with the 3 tables shown in the illustrations.

One of the conferees in pointing out that his company has practically $3,000,000 worth of returnable spools and reels in circulation today, expressed his conviction that a reduction in the number of sizes and varieties of those articles would release approximately one-half of this "frozen" investment, and that the method outlined by the Simplified Practice Committee was the logical means to the desired end.

This point of view was entertained by the other conferees. They also concurred in the belief that the first step of the meeting should be directed toward isolating those elements of the proposed program that could be tentatively settled immediately, reserving the contraversial points for the further study of a Standing Committee composed of representatives of all interests. (The personnel of this Committee is listed at the end of this article).

On this basis the conference unanimously moved that the table "Take-Off Reels" be referred to the Standing Committee for further study, revision and expansion, and that the manufacturers and users of wooden and combination spools be invited to participate in such a study.

In considering "Annealing Reels" the conference expressed the thought that the 457-pound reel might advantageously be increased to an even 500 pounds. The conferees also emphasized the good that would be accomplished if the Standing Committee will consider all the needs of stranding machines, cradles, swings and the space between the blocks. Such a study would point the way to lowering the expense incident to affecting machine adjustments. The

establishment of a uniform traverse would make it necessary for the industry to use only one size of stranding machine cradle in handling all sizes of annealing reels. It is desirable that variations in the dimensions of the reel be confined to the barrel.

It was the opinion of the conference that the scope of the last table in the agenda could best be expressed by the title, "Metal Spools for Annealing, Handling and Shipping Wire." The only other action taken in respect to this table was the recommended deletion of those spools that carry ONE and THREE pounds of wire, respectively.

Results

The chief result of this conference was the establishment of a Joint Standing Committee of the entire industry to carry on and extend the work inaugurated by the Simplified Practice Committee of the manufacturers of metal spools and reels. This Standing Committee, the personnel of which will be announced later, will be composed of representatives of all the elements in the industry.

While the industry may feel that this Simplified Practice Recommendation represents only a very light attack upon the general problem, it must be remembered that only by taking one short step at a time, (and that successfully), will the industry achieve its ultimate objective. A problem that has as many ramifications as this one cannot be completely solved in one stroke. By nibbling off a small morsel at a time, real progress will be made, provided all interests consistently maintain the courage of their convictions by progressively adhering to the program, as it is developed and enlarged.

Signed acceptance of this limited recommendation will serve as a tangible indication to the Standing Committee of the industry that the necessary support and cooperation await any reasonable schedule of sizes and dimensions that may be recommended. No additional steps towards reaching ultimate satisfactory spool and reel

Continuous Wire Drawing Machinery

Light, simple, and compact; a rapid machine of the ball bearing type for economical production.

No. 1 Intermediate Machine — Capacity .064 to No. 28.

We will furnish information on other sizes.

NATIONAL HARRIS WIRE CO.

605 North 3rd Street **NEWARK, N. J.**

A SCOTT TESTER

For Wire, Sheet Metals and Other Materials

A simple, practical recording tensile testing machine

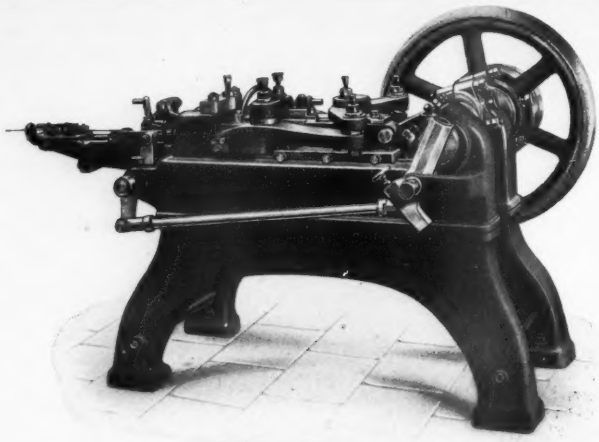
Maximum Capacity 2000 lbs.

The test results are automatically recorded on standard letter size forms (8½x11 in.) The machine is easily handled; is safe and strong and free from delicate parts. Does not require a trained operator or technical man.

Manufactured By

Henry L. Scott Co.

101 Blackstone St., Providence, R. I.



WAFIOS SPEEDY NAIL PRESS---600 NAILS PER MINUTE

CHAIN LINK FENCE MACHINES
POULTRY NETTING LOOMS
WAFIOS GEM CLIP MACHINES
NAIL AND NAIL MAKING MACHINERY
BALE & BAG TIE AUTOMATICS
ROTARY WIRE STRAIGHTENERS AND CUTTING MACHINES
SPRING COILERS AND FOUR SLIDERS
PIN AND SAFETY PIN MACHINES
FLEXIBLE METALLIC HOSE MACHINES

Wafios Wire Working Machinery

J.I.BERNITZ
25 BEAVER St NEW YORK CITY
GENERAL AGENT FOR USA AND CANADA

Specialists In Wire Working Machinery

"What is the WEAK SPOT in Annealing?"

"Personnel?"
"No!"
"Facilities?"
"No!"
"What, then?"
"OBSOLETE METHODS!"

OBSOLETE methods cost money in the plant that relaxes a constant vigilance.

When a furnace manufacturer relates of saving $2.58 on fuel cost per ton of metal annealed you can make up your mind that there is "Something rotten in Denmark," for this "saving" is four times as much as the cost should have been.

The cost for fuel per ton of metal annealed should not exceed $.60 (sixty cents). It is. therefore, incompatible with modern methods to effect a saving of $2.58. Only by comparison with methods long obsolete could such a "saving" be effected.

If you will advise us of the kind and volume of annealing you do, we will show you some facts and figures that will convince you of the merits and economy of the Bellis Lavite Process for Annealing.

THE BELLIS HEAT TREATING COMPANY
Branford, Conn.

standards will be considered effective until the industry as a whole has examined each proposal and has gone on record as being in accord with the recommended practice.

Personnel of General Conference on Metal Spools and Reels

Bassett, R. E.—American Brass Co., Waterbury, Conn.
Bilger, W. A.—American Pulley Co., Philadelphia, Pa.
Broderson, H. P.—General Electric Co., Schenectady, N. Y.
Buckman, L. F.—Baltimore Copper Smelting and Rolling Co., Baltimore, Md.
Cotter, William W.—American Brass Co., Waterbury, Conn.
Gantt. Chas. S.—Baltimore Copper Smelting and Rolling Co., Baltimore, Md.
Green, Burton R.—Decorated Metal Mfg Co., Brooklyn, N. Y.
Kerschner, Edward—Standard Underground Cable Co., Pittsburgh, Pa.
Littlefield, Arlon—New England Butt Co., Cranston, R. I.
Mossberg, Frank—Mossberg Pressed Steel Corporation, Attleboro, Mass.
Nuber, H. D., Lt., U. S. N.—Bureau of Supplies and Accounts, Navy Dept., Washington, D. C.
Nye, Theodore H.—Morgan Construction Co., Worcester, Mass.
Parsons, N. B.—Belden Mfg. Co., Chicago, Ill.
Petzing, Edwin R., Capt.—Office of Chief Signal Officer, War Department, Washington, D. C.
Smith, L. B.—Frank Mossberg Corporation, Attleboro, Mass.

Department of Commerce
Becker, Luther—Iron and Steel Division.
Braithwaite. W. E.—Division of Simplified Practice.
Ely, Edwin W.—National Committee on Metals Utilization.
Jones, M. T.—Electrical Division.
Way, H. E.—Electrical Division.

New Developments in Copper Wire Drawing

(*Continued from page* 197)

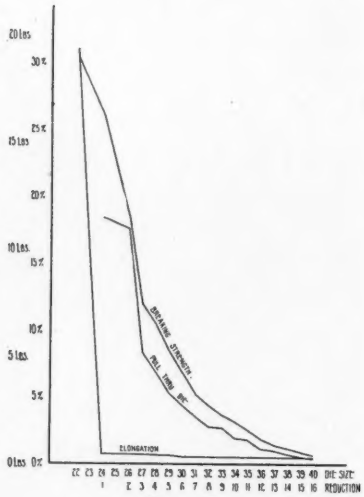


FIG. 17

the drawing minimum after the first pass, and remained at that point throughout the process.

Fig. 16 (Page 197) shows effect of five-die reduction on elongation and tensile strength. It

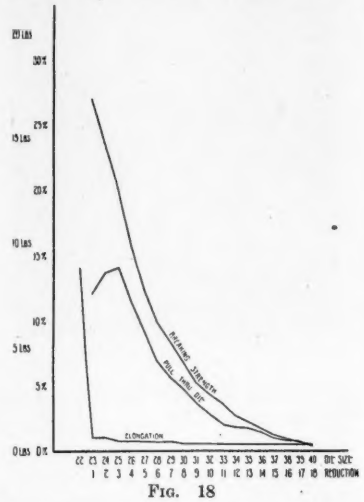


FIG. 18

may be seen that the elongation drops very rapidly at the first die when a reduction in area of about 42½ per cent is made, and the tensile strength increases rapidly because of the cold working of the metal.

This same figure shows the tensile strengths obtained when five-, six- and seven-die reductions are used to produce line wire of 0.104 diameter from the same supply. Here the elongation loss is about the same in each case, but the tensile strength is greater with the heavier reductions. The five-die arrangement is satisfactory according to the results shown on the curve, but the heavy reduction at the first die often results in rough or slivered wire. The six-die arrangement, therefore, gives the greatest factor of safety. The seven-die arrangement is less satisfactory since the elongation and tensile strength in the finished wire are so close to the requirements.

The use of A. W. G. reductions for the finer sizes of cable and magnet wire provides flexibility, since a change in the size of wire can be accomplished simply by increasing or reducing the number of dies used. Tests were conducted to determine the gain by using heavier reductions and annealing the wire before redrawing, and Fig.

(*Continued on page 207*)

A LITTLE "KINK"

---*that will save you money*

MANUFACTURERS have found that cleaning wire the OAKITE way, before pickling, saves money. Action of the acid is speeded up. There is less acid bath pollution. Time in pickling is saved. Also quantity of acid used.

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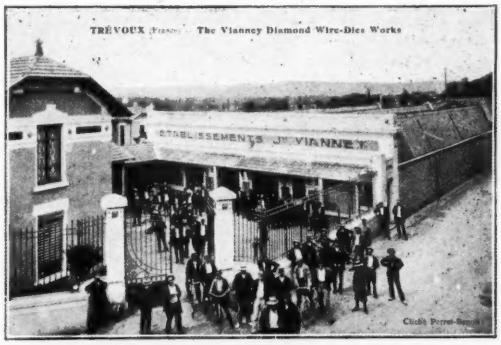

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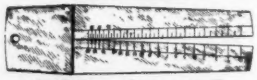
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NEWS of the INDUSTRY

THE American Steel and Wire Co. will start the first of a series of new developments, very shortly, in the form of a one-story addition to the local plant at 208 So. La Salle St, Chicago, Ill. The construction of this 100x150 ft. addition plus the cost of the equipment will total more than $150,000. The contract has been given to Benjamin Wright, 326 West Seventh St., Anderson, Ind.

THE Atlantic Wire & Iron Works, 1638 Fulton St., Chicago, Ill., is planning the addition of a three-story addition to its plant, having already chosen H. J. Pafelbach, 956 No. Michigan Ave. to make the plans. The contract for the building of this addition, which, together with the equipment, will amount to approximately $65,000, has not been given to anyone as yet, but bids will be received this month.

THE Clark Metal Products Co., Inc., 490 Hancock Avenue, Bridgeport, Conn., has been organized with paid-up capital of $75,000 and has rented space in the building formerly occupied by the Columbia Graphophone Co. The company will manufacture wire forms among many other products.

ACCORDING to the balance sheet of Feb. 28, 1927, of the Morgan Engineering Co., Alliance, Ohio, its total current assets are $1.335,244 and its total current liabilities are $439,456.

THE common stock of the Wheeling Steel Corp. yielded 83c whereas last year, although in the same period, that is the first quarter, it yielded $1.05.

FERDINAND GRIMM, Vice President of the Buffalo Wire Works Company, Inc, located at Buffalo, N. Y., died Sunday, April 24th at his home, 1098 Ellicott Street, after a long illness.

Mr. Grimm was 61 years old —born in Heimstetten, Hohonzollern, Germany, February 7th, 1866, and came to America at the age of 18 years.

After some years in retail hardware and road-work in the wire trade he become associated with Scheeler's Sons.

Constantly increasing the sale of wire products of Scheeler's Sons, who in 1903 were incorporated under the name of Buffalo Wire Works Company, he was admitted into the firm as a director and Vice President, and was also appointed general manager of their plant at Buffalo, and the branch at Philadelphia.

Mr. Grimm was also President of the Buffalo Galvanizing & Tinning Works, Inc., a subsidiary of the Buffalo Wire Works Company, as well as President of the Security Savings and Loan Association, of Buffalo.

Surviving Mr. Grimm, are his widow, Rose Scheeler Grimm, and one daughter, Mrs. Leonard Gentsch.

THE Eastern Insulated Wire Co., Tilton, N. H., has leased a portion of the mill of American Woolen Co. for manufacture of insulated wire.

Copper Wire Drawing

(*Continued from page* 205)

17 (Page 204) shows the increased reduction possible at the first die when the metal is plastic. An annealed No. 22 gage wire of 31 per cent elongation was reduced to No. 24, two gages, in one draw. The soft copper permitted a double reduction at the first die, but the elongation dropped during the operation to less than 1 per cent; the second reduction on this test was from No. 24 to No. 26 gage and the pull required for this pass practically coincides with the breaking strength of the wire. Wire drawing under such conditions is impractical because the annealing operation is much more expensive than drawing hard wire from No. 22 to No. 24 in two passes.

Fig. 18 (Page 205) shows results obtained when drawing annealed wire with A. W. G. reductions. The large margin of safety between the pull required and the breaking strength of the material again disappears after two reductions. Fig. 19[8] (P. 208) shows practical drawing conditions adopted for drawing wire to finished sizes without annealing during the process.

Chilled Iron Dies

The dies used for drawing heavy wire are cast with a tapered pole from chilled cast iron and reamed to the desired size. When the die wears too large for a particular size of wire, it is reamed to a larger size and used in that manner until the dies goes above the maximum size used. These dies, (Fig. 20, Page 197) are used for drawing line and heavy gage wire for which the cost of diamond dies would be excessive. Many alloy steel dies have been tested as substitutes for chilled iron dies for copper wire drawing, but so far have failed to replace them, due to excessive cost. For the wire sizes smaller than No. 16 down to as fine as No. 42 B. & S. diamond dies as described below are used.

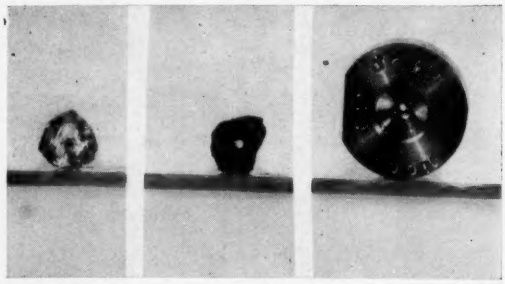

Fig. 22 — Diamond before drilling; drilled and lapped ready for mounting; and die ready for use.

Diamond Die Study

It was necessary to make an extensive study of the manufacture of diamond dies because dies through which wire could be satisfactorily drawn at low speeds failed to draw to gage and without excessive breakage of the wire as the speeds were increased. At this time practically all commercial diamond drilling was done in Europe, Belgium being the hub of the diamond cutting industry and the art was new to this country. The diamonds generally used for wire drawing

8. Slight irregularities in the curves are due to variations from the mean in the diameters of the dies used during the tess.

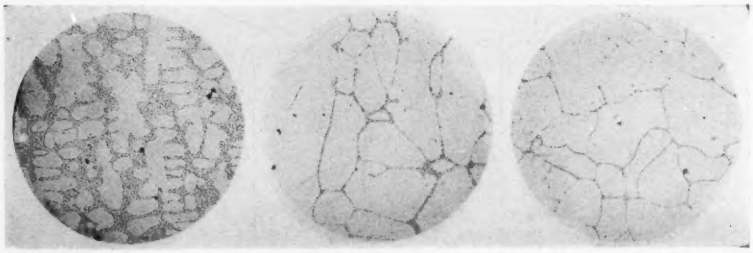

Fig. 25—Photomicrographs of wire bar (X33). A. High set—Oxygen 0.035%; B. Level set—Oxygen 0.05%; C. Low set—Oxygen 0.12%.

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obtaining dies for drawing wire dies are obtained from South Africa[9], Australia, and Brazil, and made into diamond dies in Europe.

In view of the difficulty of at high speeds and the large investment in dies required for the proposed wire mill, it was decided to undertake a laboratory investigation of the manufacture of diamond dies suitable for drawing cable and magnet wire.

It was found that the dies suitable for high-speed wire drawing required a differently shaped approach, a better polish, and a shorter land[10] than used for low-speed drawing. In addition the origin of the stone, the shape of the diamond and its setting are all very important because of the internal strain to which the die is subjected during the drawing operation.

It has not been possible to definitely establish any quantitative relationship as to the effect of high-speed drawing on the wear of dies except that about the same number of million feet of wire may be expected from a properly lubricated die irrespective of the drawing speed. Under such conditions, the high-speed die naturally runs a shorter time,

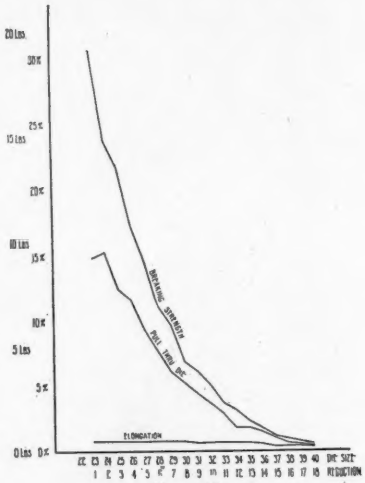

FIG. 19

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9. The South African and Australian diamonds are the more suitable for wire drawing There are two types of the former, the smooth brown premier which is not suitable for dies because of its tendency to crack and split, the other commonly know as the Jager, a product of the Jagerfontein mines. These stones, very irregular in contour and light gray to black in color, are most suitable for dies. The Australian diamonds are gray to brown to almost black in color and can be distinguished from the Jager. Many of the Brazilian diamonds are a dark gray similar to graphite in color and not being translucent are difficult to inspect for seams, cracks or inclusions.

but length of life is not the important factor; tonnage of a satisfactory quality with a minimum plant and labor investment is the prime consideration.

Fig. 22 (Page 207) shows a diamond before drilling, a stone drilled and lapped, ready for mounting, and a die in the final mounting ready for use.

Annealing

Hard copper wire is obtained by using the wire as it comes from the wire drawing machine. This same wire may be softened by annealing, or medium-hard wire can be produced by annealing hard wire at such a point in the drawing operations that the final draws will give the desired degree of hardness[11].

In a commercial type of annealing furnace, Fig. 23 (Page 197) wire may be bright annealed, but it requires a drying operation to remove the water through which it passes in leaving the furnace. The retorts of these furnaces are water-sealed and filled with steam to exclude the outside atmosphere, which would discolor hot copper. To obtain bright wire, it is passed under water into the retort to exclude the air and is generally taken out and cooled under water or in an atmosphere of steam or gas, which excludes oxygen until the wire is relatively cool.

A special steam-seal annealing furnace for small spools of wire was developed on an experimental basis from which the wire was obtained bright annealed and free from moisture. In this furnace the spools were submerged in water to displace the air, raised into the charging end which was under water, thence to the muffle to be heated and then along a cooling tube to the discharge opening. Air was excluded from the retort and cooling chamber at the discharge end by means of a steam jet.

The success of the small fur-

11. "Experiments in the Working and Annealing of Copper," F. Johnson, Journal Institute of Metals, Volume XXVI, No. 2, 1921.

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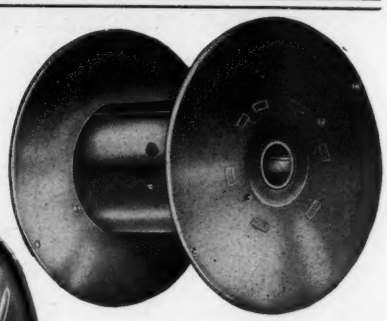

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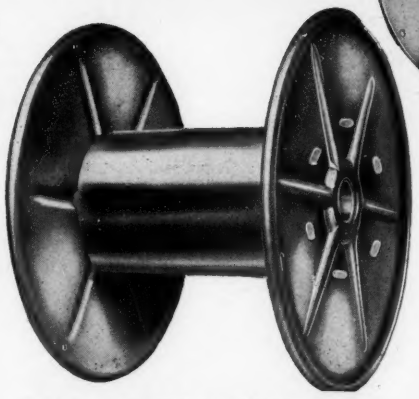

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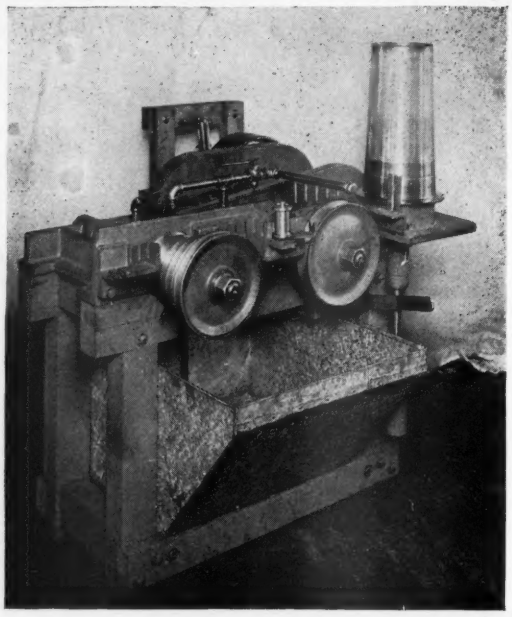

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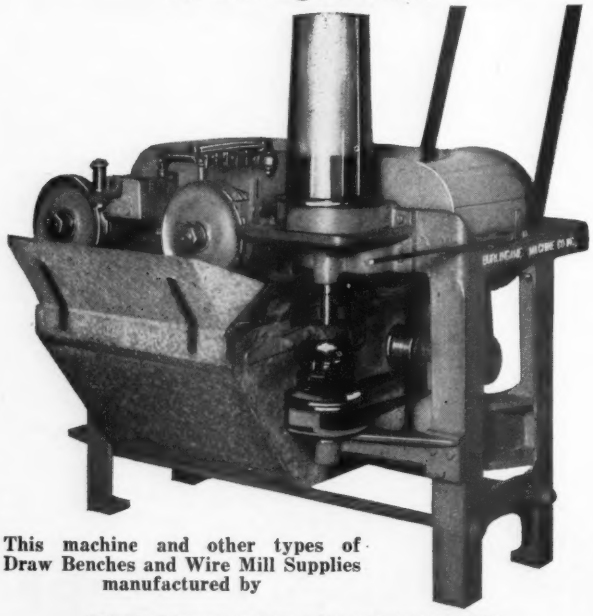

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nace led to the construction of a larger machine (Fig. 24, p. 196) for annealing cable wire on spools. The spools are placed in perforated metal baskets which are charged into the furnace at a specified time interval, pushing each other through the retort and along the cooling tube to the discharge end.

Inspection of Raw Material and Finished Product

Wire bar made from electrolytic refined copper is used as a material in the manufacture of wire. This material is practically free from silver and other elements which ordinarily exist in the ore, and which have a detrimental effect on the electrical or physical properties of the finished product. A small percentage of silver[12] seriously affects the annealing qualities of the wire. Traces of other impurities have a very detrimental effect on the wire drawing properties. During the refining process, the molten bath is oxidized in order to carry off the foreign material in the form of slag, and it is very important that the oxygen content be later reduced to a very small point if bars of proper set are desired. Fig. 25 (Page 207) shows photomicrographs of wire bar with varying amounts of cuprous oxide[13]. Ordinarily the surface condition on top of the bar is a good index of the oxygen content. If the bar is level set or slightly convex on top, it is usually a satisfactory material. If it is low set or concave it usually contains a large amount of copper oxide, which caused the metal to shrink in solidifying[14]. When excessive shrinkage occurs it has an adverse effect during the rolling operation.

The finished wire is inspected for dimensional limits, tensile strength, elongation and surface condition. Limits for 42 B. & S. gage wire 0.002475 are 0.00245 minimum and 0.0025 maximum.

12. "Effects of Silver on the Recrystallization Temperature of Copper," Caesar and Gerner, A. S. M. E., Volume 38, 1916.

13. "Microscopic Structure of Copper," H. P. Pulsifer, Mining and Metallurgy, January, 1926.

14. "Copper Refining" Lawrence Addicks. "Metallurgy of Copper" H. O. Hofman.

Research on the Mechanical Properties of Steel Wire

(*Continued from page* 195)

patented- and finished-wire increases in proportion to the increasing carbon content, that is to say, an increase of 0.1 carbon content equals a 10 kg. per mm^2 increase in tensile strength. The bending strength as well as the number of torsions increases —other factors being equal—as the carbon-content increases.

3. The tensile strength increases in the beginning in proportion to the increasing reduction, but rises more rapidly as the reduction becomes heavier. Decrease of the tensile strength has not been observed after a certain degree of reduction has been reached. The bending and tensile-strength-curve run parallel provided the bending radius of the wire remains constant. Decrease of the flexion-test-numbers has not been noticed in connection with extreme cross-sectional reductions. All wires bent over a certain radius (r) (r equals two times wire diameter) registered with constant flexion-test-numbers. The number of simple torsions (1-100.d) sometimes decreases with decreasing wire-diameter. The test of hardness uniformity by "long-loop-torsion-test" gives constant valves up to a certain reduction—the limit is determined by the quality of the raw material and the carbon-percentage; the drop indicating the limit of drawing for the metal. The simple torsion-test-numbers decrease with decreasing reduction. Tensile strength being equal, the torsion-test-numbers of wire drawn from smaller diameter rod surpass those drawn from heavier rod.

4. Drawing with smaller reductions (light drafts) results in relatively smaller tensile strength of the finished wire, but higher bending test and torsion test number.

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5. For manufacture of wire which is subject to repeated alternate torsions (hoisting, and crane rope) preferably steel of higher carbon content is used. Since for higher carbon content less cold working is required to give the same tensile strength, the torsibility and flexibility are increased. For the same reason one chooses a rod diameter as small as possible.

6. The testing methods for rope wire cannot in view of the results obtained, be regarded as adequate. In addition to methods heretofore used, (Tensile, Flexion, and torsion test) it is advisable to test the uniformity in hardness by the "long loop," and the resistance against repeated strain by alternate torsion tests.

7. In conclusion we gave a simple curve-system which will enable the engineer to determine the proper diameter for the rod from which to draw finished wire of specified diameter and tensile strength.

Relation of Steel Quality to Drawing

(*Continued from page* 189)

firmatory results. It was found that when very light drafts were taken the resulting concavity was very small, but when heavier drafts were taken the cavity became deeper. This method, however, is manifestly defective, inasmuch as the material inside the cup is not supported, and, consequently, would draw out considerably more after each draft than if it were solid.

With the object of having the wire solid and at the same time being able to detect the relative "flow" of the material during drawing, several attempts were made to butt-weld different steels, subsequently sectioning them and noting the result. Two pieces of 5-gauge mild steel rod were carefully butt-welded by the electrical resistance method after the ends had been squared, as it was known that the junction would be somewhat decarburised and would give an area of material which would differ in appearance from the main portion of the rod. The rod was then drawn from 5 to 12 gauge wire in five drafts. The welded joint was then carefully sectioned, and when etched appeared as shown in Fig. 12. From this it will be seen that the centre of the section low in carbon had moved in advance of its outside.

A similar experiment was carried out by butt-welding two rods having such diverse carbon contents as 0.60 per cent. and 0.05 per cent. After air tempering, the 5-gauge rod was drawn down to 10-gauge wire in five drafts, the high carbon end of the rod passing first through the drawplate. Careful sectioning of the resulting wire showed that there was apparently no difference between the "flow" of the core and the skin of the wire.

It would appear from the above experiment that in reducing hard steel by comparatively light drafts there is very little relative movement between the centre and the outside of the wire in passing through the drawplate. This part of the investigation leads directly to the question of segregated material, which is one of the bugbears of the wire-drawer who desires to manufacture a high-class product.

(To be continued in next issue)

New Wire and Rod Mill

(*Continued from page* 196)

to install another unit of like capacity.

Muriatic Acid storage equipment consists of four 2500 gallon wooden, rubber-lined tanks, making a total storage capacity of 10,000 gallons. An electric motor driven Duriron pump and necessary piping is located in a brick pump house, arranged to

transfer acid from tank cars into the storage tanks and to pump from them into a rubber lined measuring tank in the wire galvanizing room.

The equipment at Sparrows Point can do the heavier galvanizing required by telephone and railroad specifications. These include the so-called "four minute" tests. Experience has shown that with this standard equipment as heavy galvanizing can be done by the methods used as by any equipment in existence.

Barbed Wire Department

The Barbed Wire Department is housed in a building 75 feet wide by 225 feet long, which is also of the same general construction as the other buildings. Here are located machines for making four-point Glidden, four-point Invincible, four-point Cactus, four-point Conemagh, two-point Glidden and other combinations. The machines are arranged in a group and driven from a line shaft through quarter turn leather belts. The line shaft is driven by a 50 H. P. electric motor at a speed of 250 R. P. M.

Rod Shipping Warehouse and Shipping Platform

Shipping facilities are very important factors in the expeditious handling of material. Those provided at Sparrows Point are exceptionally good. Facilities for the bulk shipment of rods, wire and wire products are provided by a shipping room and finished stock warehouse 1525 feet long by 75 feet wide, with a storage capacity for 1800 tons of rod and with 900,000 cubic feet of space for wire products.

The twelve feet wide shipping platform is also 1525 feet long, and affords ample room for all shipping requirements. Another outstanding feature of this platform, aside from its length, is the roof which extends out over the middle of the cars and protects the entire platform, precluding weather interference with the loaders and their work.

Another article dealing with the new wire and rod mill of the Bethlehem Steel Co., will appear in the July issue.

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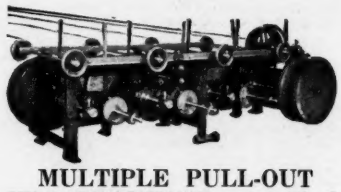

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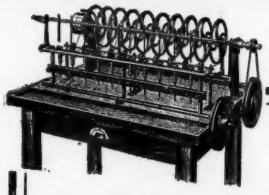

"POHENKRA" WIRED POLISHING MACHINE

Indispensable For All Kinds of Wire-drawing

U. S. Patents
983929—1911
1039186—1912
England 16171
1910
France 420503
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Gives an absolute guarantee of grinding the diamond holes perfectly round, a result hard to accomplish with all devices employed before.

Simultaneously grinds the entire wall of the draw stone, including the inlet and outlet.

Ten times more effective than previous devices; one workman unassisted can polish 30 diamonds simultaneously.

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Forms Eleven Sizes of Eyes from Round, Square, Flat or Half-Round Stock, also almost any shape desired Quickly and Efficiently.

Adjustable for No. 3 to No. 24 Gage Wire.

The cut on the left shows a few of the thousands of the forms made on this

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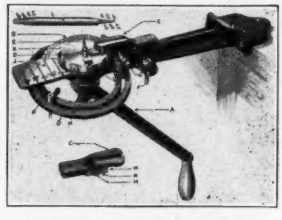

Patented April 2, 1918

M. D. Kilmer & Co.

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Box 237, Station B.

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Complete, accurate tensile tests, including stress-strain curves in rectangular co-ordinates, in 4 seconds.
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Testing Engineer
Complete Line of Machines and Instruments of High Quality for Testing Wires and Wire Ropes
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"Could you publish an article" wrote The — Wire Co. "on the nature of hard inclusion in steel wire?"

FRANKLY, we were not aware that this particular problem held any immediate interest for our readers. A few inquiries, however, convinced us that we were wrong—that information on this subject would find an eager and appreciative audience among the trade. Already, the article is in preparation and will see the light of day in the July issue.

Other subjects, other articles, other problems may have been neglected. If there is any angle or any phase of any problem that you believe would be of interest to our readers, we shall be glad to treat the subject in Wire and Wire Products.

The coupon is for your convenience.

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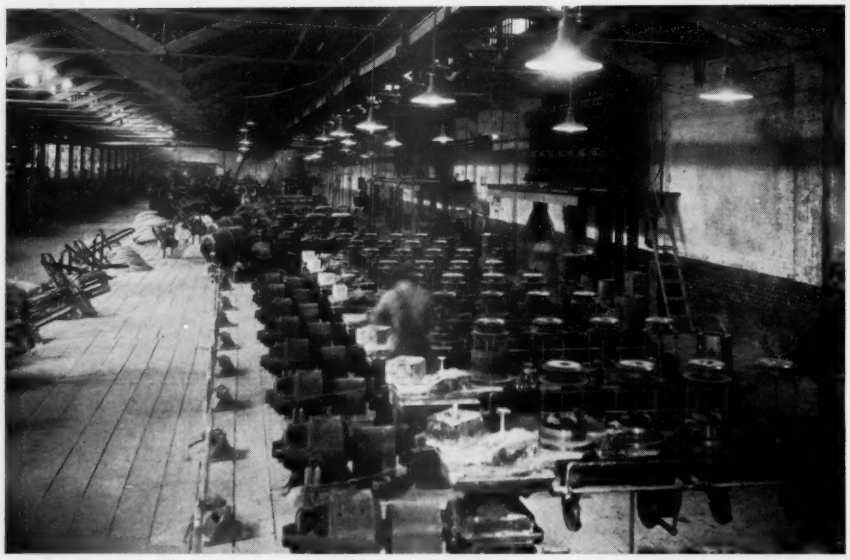
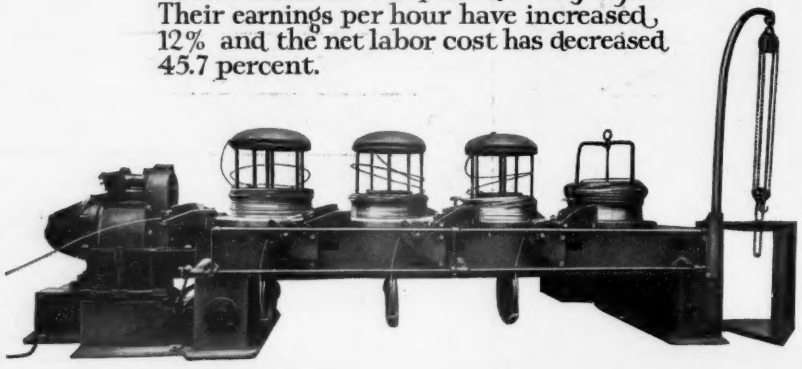


Through this installation of
Morgan Connor Wire Machines
twelve men have replaced *twenty-eight.*
Their earnings per hour have increased 12% and the net labor cost has decreased 45.7 percent.



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